The Electrical World.

VOL. XXVIII. NEW YORK, OCTOBER 24, 1896. No. 17.

PUBLISHED EVERY SATURDAY BY

THE W. J. JOHNSTON COMPANY,

253 Broadway, New York.

Established 1874. Incorporated 1889.

Telephone Call: Cortlandt 924. Cable Address: "Electrical," New York

New England Office, 620 Atlantic Ave., Boston.

Western Office, 936 Monadnock Block, Chicago.

Philadelphia Office, 927 Chestnut Street.

SUBSCRIPTION IN ADVANCE, ONE YEAR, $3.00,
in the United States, Canada or Mexico; other foreign countries, $6

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ELECTRIC TRACTION.

We present to our readers in this issue of THE ELECTRICAL WORLD a series of articles bearing upon electric traction which are of especial interest at this time, inasmuch as they involve problems which are of particular importance to railway engineers. This departure from the past custom in convention numbers to present detailed descriptions of electrical and other features of the convention city will, we believe, prove of far greater interest and certainly of more value to our readers in general. The article by Mr. Herzog on the Budapest underground electric railway sets forth in a necessarily brief manner the chief features of this road, which was opened a few months ago. Underground traction is at the present time attracting a great deal of attention, and the satisfactory solution obtained in Budapest warrants the belief that roads built upon similar lines would be successful in this country also. A description of the new Heilmann locomotives now being constructed in France, treated of in this issue by Mr. Leonard, is of much interest, although its principle features, including the system of control devised by Mr. Leonard, have heretofore been quite thoroughly discussed and unfavorably criticised by many. The tests, which have been carried out on a locomotive of this type, seem to demonstrate quite a few advantages, and show that the coal consumption, as compared with steam locomotives of equal capacity, is considerably less. The locomotive also possesses all the advantages of electric locomotives for power purposes, so that instead of the draw-bar pull decreasing with an increase of speed, as with steam locomotives, it may be made to remain constant. It is claimed by several that the improvements which have been effected in the Heilmann locomotive, such as increased boiler capacity, increased tractive effort, greater indicated horse-power and other desirable features, will be obtained by improving the steam locomotive on the same lines. These claims, however, have not been verified in practice, and it is questionable whether the steam locomotive is not rapidly attaining the height of its perfection. Several of the advantages which are possessed by the Heilmann type of locomotive are, however, offset by increased first cost, the interest on which, together with depreciation, will decrease to a large extent the economy resulting from less coal consumption. Mr. Leonard points out several advantages which he thinks the Heilmann locomotive possesses over the type now employed in tunnel work. This electric locomotive being entirely independent of all overhead or trolley construction certainly possesses advantages in this respect, and for this and other reasons it possesses the possibilities of demonstrating at least one form of solution of the electric traction problem. The value of the booster in supplying current on electric railway extensions is fully demonstrated by its successful use, as set forth in an article by Mr. Robert P. Brown. There is no better evidence needed of its value than the estimated saving in copper which was effected by its adoption. This is a most important point, and one which deserves the careful consideration of railway engineers. The article by Mr. Hering, on the contact pressure of trolley wheels, will call attention to the fact that this part of the equipment deserves more attention than is generally paid to it. An excessive contact pressure necessarily increases the wear on both the trolley wire and wheel and makes the management of the trolley more difficult, while insufficient pressure causes excessive sparking, a short life for the trolley wheel and increased liability of trolley to jump the trolley wire. Mr. Hering finds that the best results are to be obtained when the contact pressure is between 20 and 25 pounds. The advantages possessed by a thorough

road-bed construction are set forth in an article by Mr. Vickers. Although the method advocated involves a large first cost, the tendency toward heavier equipments will doubtless warrant the expense on large city thoroughfares. The use of cross-ties makes the two rails dependent one on the other, and for this reason it would seem that future practice will retain this advantage, notwithstanding the advantages to be derived from other proposed methods in which the cross-tie is not used.

THE ST. LOUIS CONVENTION.

During the present week the American Street Railway Association meets for the fifteenth time under auspices that in many respects may be regarded as most favorable. To begin with, St. Louis, on account of its central geographical location, will on this occasion attract many delegates who in all probability would not attend the meeting were it being held in some city nearer to one of the borders. In looking at the association retrospectively and contemplating its present standing among similar organizations, it is remarkable what progress it has made in its particular line of work. Each meeting is more interesting and more successful than its predecessors, and the character of the attendance indicates the development of a powerful influence beneficial to the street railway business. The character of the papers presented at each successive meeting is perhaps the most reliable index of the association's development, and it is plainly noticeable that the old street railway men, who were formerly better judges of horseflesh than of electrical machinery, now get up in the meetings and discuss the theoretical questions arising in connection with their business with quite as much erudition as does the younger generation, which has derived its knowledge within the precincts of a classic seat of learning. The American Street Railway Association is accomplishing a great deal of good for its members and exemplifies the benefits resulting from unity of purpose and action. In its membership are found men of unquestioned ability and of the highest standing in the communities in which they live, and it is to their credit that they take great pride in their association. The papers at this present meeting, while not numerically great, are of the most practical kind, on subjects that appeal most strongly to the street railway men, and what is lacking in numbers is likely to be made up in quality. So completely has electricity occupied the street railway field of development that practically all problems which now occupy the attention of street railway men involve solutions of a more or less electrical nature. The construction, maintenance, bonding of track, and track joints are matters of the deepest concern to the practical railway man, and will be presented for the consideration of the convention in the form of a paper. Track construction is practically standardized, but the track-joint problem cannot be said to have been satisfactorily solved. That this problem is a matter of the greatest importance to the railway business is evident from the number of methods of effecting joints that have been brought forward. Many of these have died in infancy, others have struggled hard to gain a foothold and recognition, only to find an early grave, while others have lived and have proved fairly successful. The doctrine of the survival of the fittest applies as well to track joints as to every other material thing. The paper that will probably appeal strongest to the railway manager will be that on "How can the Revenues of Street Railways Be Increased, Taking Into Consideration the Collection of Fares, Method of Registry, Transfers, Use of Tickets or Cash Fares, and Attractions Along the Line of Road." It is popularly supposed that electric railways are veritable mints, but in many cases the reverse is true. Many railway companies are under enormous expense, brought about by the very laudable desire to give the public the best service possible, and it is but business prudence to seek to establish a greater difference between the income and expense accounts in favor of the former. The transfer question is yet an open one—as far as the best practice is concerned—and the subject of furnishing popular attractions along the line of the road is one of the most important presented to railway managers at the present time. Parks and other attractive resorts form the chief source of revenue of many lines, but in other cases experience of this kind has not been profitable. Therefore the resort problem is one that can only be considered in the light of each individual case—the conditions necessarily differing in different localities. Modern overhead electric construction and the modern power-house will constitute the basis of two other important papers. Improvements in methods and apparatus, even in so short a time as a year, are so great that papers on these subjects from reliable authorities cannot fail to be of value and interest. Exhibitors of railway apparatus and appliances will be out in full force, and it is really encouraging to note the number who have made arrangements to participate in the exhibition. While all alike have felt the heavy weight of the hard times, they are dauntless and unflinching in their belief that business has not yet gone to the dogs, nor that it is likely to. We trust that delegates, exhibitors and all will derive some benefit in one way or another from their attendance at the Convention.

Magnetic Hysteresis.

In a paper read before the Liverpool meeting of the British Association, Messrs. R. Beattie and R. C. Clinker described a method of measuring magnetic hysteresis in a rotating magnetic field as employed by them and which gave results comparing favorably with other methods hitherto used. These latter methods consist either in measuring the torque exerted upon the specimen to be tested, when placed in a rotating magnetic field, or that exerted on the magnet producing the field by the rotation of the specimen.

The first mode of measuring the torque has been used by Prof. Elihu Thomson and Mr. Holden in this country, and by Mr. Baily in England. The first two of these experimenters balanced the torque on the specimen by means of a spring previously calibrated, while Mr. Baily measured the force required to keep the specimen rotating against this torque. The second method has been employed by Prof. Ewing in his hysteresis tester. In this instrument the specimen, in the form of strips clamped together, is spun between the poles of a pivoted C-shaped permanent magnet, the restoring force on which is gravity. The deflection of this magnet is nearly proportional to the hysteresis. The instrument is calibrated by two standard specimens, whose hysteresis losses have been previously determined ballistically. The authors of the above paper placed the specimen to be tested in a cylindrical bucket of non-conducting material, and suspended the whole in a magnetic field by means of a wire from a fixed support; the deflections being read by a lamp mirror and scale, and the wire being calibrated by a vibration experiment with a bar of known inertia moment, the torque exerted corresponding to any deflection was thus known in absolute measure. It was found that with the strength of field used, that with a test piece consisting of a number of transformer discs gave a linearly increasing deflection as the number of discs, starting with 10, was increased. Using this relation, which shows that the hysteresis loss is independent of the number of discs, it is possible to deduce the relation between the hysteresis loss and the corresponding induction. It was found that the exponent of $\mathfrak{B}$ came out 1.4, a figure quite near 1.6, which is quite generally accepted. The authors state that although this method appears simple, yet it loses much of that simplicity, owing to the difficulty of obtaining the true induction, especially in small specimens.

Long Distance Telephony.

In a recent communication to the London *Electrician*, Mr. Oliver Heaviside comments briefly on the proposed method of constructing submarine cables, as described by Mr. Preece. The latter favors the idea of bringing the two conductors as close together as possible, thereby reducing the inductance of the circuit to a minimum, at the same time increasing its permittance. This method leads to results directly opposed to the deductions of Mr. Heaviside, and was also unfavorably criticised by Lord Kelvin. Mr. Preece evidently would do well to carry out his plans with considerable caution.

An Experiment with an Improvised Booster on Street Railway Feeders.

BY ROBERT P. BROWN.

IN the Autumn of 1895 the Brooklyn Heights Railway Company determined to extend its Flatbush Avenue line to Bergen Beach, a new pleasure resort that was to be opened the following Summer. The new section was to be about 2.44 miles long and was 8.8 miles from the station selected to the beginning of the addition at King's Highway. This great distance made the problem of economically furnishing power rather difficult to solve.

As the beach was a new venture and would have to compete directly with several popular resorts, it was estimated that 30 cars would be more than enough to operate this section, together with about two miles of the old line that had insufficient copper erected for the increased service. On this assumption it was figured that the average heavy load would not exceed 600 amperes at an effective pressure of 400 volts.

Owing to the difficulty of providing a suitable pole-line for high voltages inside of the city limits, alternating-current transmission could not be considered for this purpose, and there remained only the choice of purchasing a sufficient amount of copper, or of installing the necessary apparatus for a booster system.

As the heavy loads would occur only on Sundays and holidays, during the Summer, it was evident that a booster could be employed to advantage if the feeding of this section was the only consideration.

The rapidly-increasing traffic of the Heights Company and the adoption of electric heaters on some of its lines rendered it imperative to change a portion of the output from the eastern station to the southern station, and to increase the copper of the down-town feeders.

As will be seen by the accompanying map, Fig. 1, the route of the wires to the Beach passes close to a section of Fulton Street, fed from the eastern station during the Summer months. It was determined therefore to run sufficient copper to feed the section without the aid of a booster, and to distribute it so that the greater portion could be used during the Winter on Fulton Street; the remainder could be used to advantage on Flatbush Avenue, which is also a heavy Winter line.

From tests made during the preceding Winter it was estimated that the loss in the return circuit would be from 40 to 50 volts. The voltage of the southern station can be safely run up to 580 volts or higher during the heavy Summer load, as the lines in that vicinity are all routes to pleasure resorts, and consequently heavily loaded. Following these assumptions and wishing to obtain an average of at least 400 volts on the section, a drop of 130 volts was allowed on

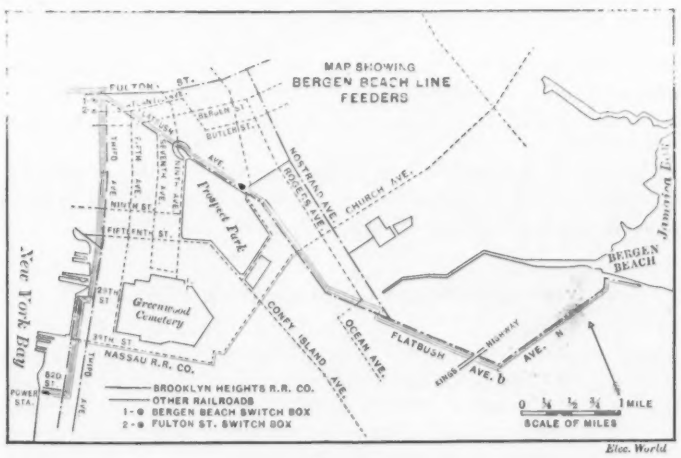


FIG 1.

Two of the wires on Flatbush Avenue had also been run, when arrangements were made with the Nassau Railway Company by which permission was obtained to use their poles for part of the way. This reduced the distance from the power station to the beginning of new road to 6.53 miles.

One wire had been run over this new route and was connected to the two other feeders at the intersection of the Nassau Company's lines with Flatbush Avenue (see map, Fig. 1) before the opening of the season at the Beach.

During the construction of the Beach road, section insulators were placed in the trolley wire at the beginning of that line, and as the feeders were not completed they were allowed to remain and the section not enlarged, as had been intended.

The Beach was opened Decoration Day, and the enormous number of people who attempted to visit it showed that its popularity had been greatly under-estimated, and a badly demoralized service resulted from this unexpected success.

In order to provide sufficient power for this unexpected rush a booster was improvised from one of the railway generators at the station. The series-coils on equalizer were disconnected, a resistance placed in the leads of the shunt field coils, and the dynamo cut in series between the feeder bus and one of the feeders. As the result of this experiment it was decided to increase the copper on the Flatbush Avenue section, and apply this method on the new line.

The generators at this power-station are four-pole, 600-volt machines, made by the General Electric Company, and are of the earlier type M. P. 500-kw dynamos built by that company. These generators run fairly well at a load as high as 600 amperes, with potential as low as 50 volts. They are arranged in pairs, two dynamos being coupled to a jack-shaft belted directly to an engine. As the load proved too heavy for one generator, two driven by the same engine were used. This was done chiefly to save labor in making connections, but was considered safer, as there was no equalizing wire. The dynamos were not in multiple with each other until at a distance of 3.7 miles from the power-station, and so would probably run all right together, even at different speeds.

The accompanying diagram, Fig. 2, shows the manner of connecting the dynamos for this service. As will be seen, the series-coils and equalizer were disconnected; a second rheostat of the same type as the one regularly used was connected in the leads to the shunt fields of each machine, which were excited from the bus; at the switchboard the leads from the circuit-breakers to the negative bus were transferred to the feeder bus and the leads from the positive switches were disconnected from the feeder bus and connected to the Bergen Beach feeder *via* Third Avenue. When desired the

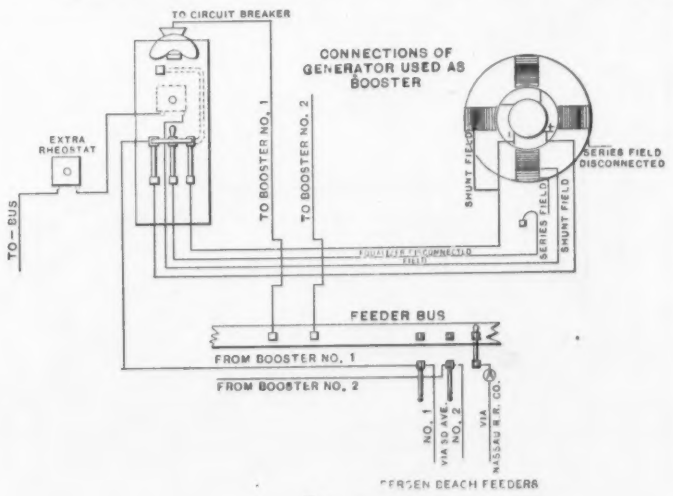


FIG. 2.

the feeders, between the station and the beginning of the new track, then considered near the centre of feed for the section. As the distance is 8.8 miles it would require four conductors of 500,000 circular mils each for the entire distance, and one of 500,000 circular mils six tenths of the way. In order to receive the greatest benefit for the entire year it was decided to run five wires from the power station to Flatbush Avenue, so that they could be used on Fulton Street when not required for the Beach line, and the remaining amount of copper be distributed on Flatbush Avenue.

Four of the five wires were wanted for immediate service and were therefore erected and used on Fulton Street during the Winter.

dynamos were brought up to speed, the resistance of both rheostats turned in, the feeder switches opened and the machines put in circuit in the usual manner. The extra rheostats were allowed to remain connected, as the same dynamos were used as boosters throughout the season. The other changes and connections could be made in a very few minutes, so that the dynamos were not withdrawn from their regular service except when needed.

The feeder, run by the way of the Nassau Railway Company's lines, was left connected to the feeder bus; as it was provided with an ammeter it was used as a potential wire to that point on Flatbush Avenue, where it was connected to the other feeders. The voltage

on the boosters was regulated so as to allow enough current to flow through this feeder, to show that the voltage at the junction was lower than at the station by a trifle more than the ground drop.

This arrangement worked fairly well until a bad block occurred at the junction of Nostrand and Flatbush Avenues, caused by a disabled car and the impertect switching facilities at this point, where a single curve connected to double track lines. The accumulated cars passing on to the Beach section in a bunch overloaded the feeders that side of the test point, and the voltage became so low that they could scarcely move. It was then noted that the loss in the return circuit was considerable more than was originally estimated, as the drop for that distance of the feeders would not account for the low voltage obtained. The feeder that had been used as a potential wire was immediately extended from the point *A* to the point *B*, as shown on the map, a distance of 2.41 miles, the first connection removed and another made at the end.

The final arrangement was as follows: Three conductors of 500,000 circ. mils from the power-station to Thirty-ninth Street (.19 of a mile) connecting to four of 500,000 circ. mils extended to Flatbush Avenue (2.88 miles). These connected with two conductors of 500,000 circ. mils, one ending at the terminus of the line, a distance of 7.57 miles; the other was shorter by about .53 of a mile.

These feeders were all connected at the end of the four conductors, and the two at the Beach section were connected at frequent intervals to equalize the load. There was also one conductor of 500,000 circ. mils from the power-station to Avenue "N," *via* the Nassau Company's lines; this was 6.87 miles long. The connections at the power-station were allowed to remain the same, but the test point was thus moved 2.47 miles nearer the end of the line, and the feeder from the bus could be allowed to carry more current.

A test of the return circuit revealed a loss of over 100 volts. This large increase was due to the fact that all the Heights Company's lines toward the beach were carrying greater loads, and also that several heavy lines belonging to other companies were not in operation when the former test was made.

With the new arrangement of feeders, the road could be operated without the aid of a booster until a load of 650 amperes was reached, so they were not put in circuit until that amount was indicated.

A typical Sunday load is shown in Fig. 4, where curves are shown, platted from 15 minutes' readings of the amperes and voltage carried on the boosters and of the amperes carried on the feeder from the bus. Fig. 3 shows curves of voltage taken at the terminus of the line and of the total load on the feeders, observed simultaneously. These curves do not correspond as was expected from the fact that the voltage was bound to be affected by the varying loss in the immediate vicinity, due to the bunching of cars.

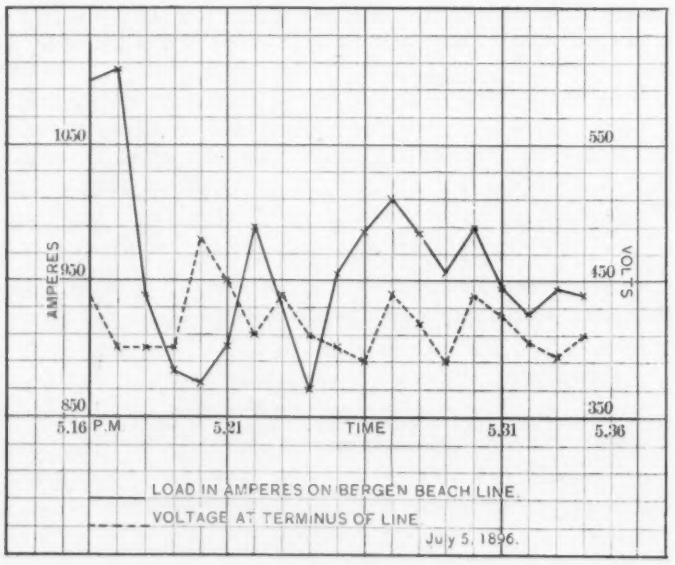


Fig. 3.

The boosters were used sixteen days during the season, and the total output was 29,393 kilowatt-hours. While the engine driving the boosters was too lightly loaded for best economy, the cost was certainly less than nine tenths of a cent per kilowatt-hour; at this price the total cost for the operation of the boosters for the season would be 29,393 times $0.009 or $264.54. No charge could be claimed for investment, as the dynamos used were part of the regular equipment of the power-station.

The feeder from the bus could not be allowed to carry more than 100 amperes during the hours of heavy load, and as the average of this output was about 1200 amperes, it follows that if no boosters had been used at least 12 such wires would have been required to successfully operate this line. As the length of this feeder is 6.87 miles —6.87 x 12 equals 82.44 miles of 500,000 circ. mil conductors would have been needed. One conductor was already erected, and the

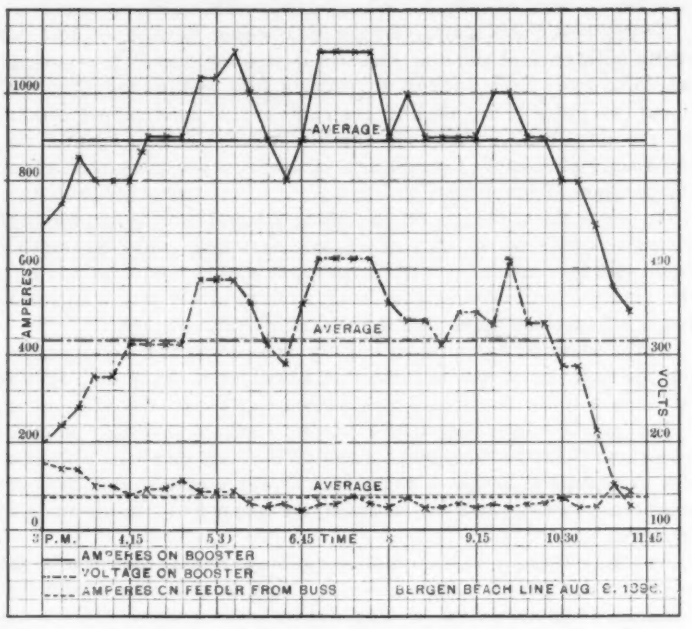


Fig. 4.

24.18 miles of feeders *via* Third Avenue is equivalent in conductivity to 2.61 conductors run the shorter way, so that additional copper to the amount of 54.63 miles of 500,000 circ. mil conductor was needed to perform the work done by the booster. As $1500 per mile is a fair price for a 500,000 circ. mil conductor in position, the cost would have been 54.63 times $1500 or $81,945, providing all of the conductors could have been run the shorter way, which was not possible.

By the adoption of this simple booster and with a loss in power costing only $264.53 for the entire season, the Heights Company was saved an investment of over $81,945, besides the loss resulting from inadequate service while waiting for the copper to be purchased and erected.

As it was found that the voltage on the line could be easily determined from the ammeter on the feeder from the bus and so regulated without difficulty, no attempt was made to render the boosters automatic.

It is possible the method could have been improved upon by properly compounding the dynamos, but it was not convenient to make the necessary experiments to settle that point.

Converting Fahrenheit Into Centigrade Degrees.

Our French contemporary *L'Industrie Electrique* gives the following simple rule. Subtract 32 degrees and divide by 2; then add to this $\frac{1}{10}$ of itself and if further accuracy is desired $\frac{1}{100}$ more. For instance, if it is required to find the number of centigrade degrees corresponding to 72 degrees Fahrenheit subtract 32 and divide by 2, giving 20; adding $\frac{1}{10}$ more gives 22 and for greater accuracy, another $\frac{1}{100}$ gives 22.2. The method is not as simple when applied to the reverse calculation.

New York Electrical Society.

The lecture of Dr. C. E. Emery, entitled "Reminiscences of Forty Years of Engineering Experience," which was to have been delivered before the New York Electrical Society on the evening of Oct. 13, was postponed on account of the meagre attendance due to the stormy weather. This lecture will constitute Pres. Emery's inaugural address.

The Electric Underground Road in Budapest.

BY JOSEF HERZOG.

DURING a period of about 20 years the question of constructing a railway through Andrasy Street, the most beautiful thoroughfare in Budapest, was agitated. but all petitions submitted to the authorities to construct a surface road of any kind for the purpose of reaching the City Park were without success, the principal cause for which was due to the fact that Andrasy Street was originally laid out with the stipulation that the construction of a street railway upon it should never be allowed. The difficulty was overcome in 1894 by the adoption of plans for an underground road. According to these plans an electric underground road was constructed on the cut-and-cover system, leading under the most beautiful part of the city, from the Danube Quay, under the magnificent "Andrasy Strasse," to the beautiful park called Stadtwaldchen, where at present the Millennium Exposition is being held. The route is shown in Fig. 7. It starts from Redouten Square, thence passes to Gisela Square, under Elizabeth Square, to Deak Square, thence to the Waizner Ring, and from there under Andrasy Street to the City Park. The public demands for traffic between the centre of Budapest and the outlying districts have been met for several years past by surface systems.

The underground road and the Millennium Exposition were opened on the same day. The essential features of the system are :

First. The tunnel built especially for this purpose.

Second. The 10 stations with waiting rooms and stairs for reaching the street.

Third. The line conductors and feeders for supplying the electrical energy for power, illumination and signaling, including the lines for communication between the individual stations.

Fourth. The railway cars.

I.—THE TUNNEL.

The construction of this very interesting railway was begun in August, 1894, and by November, 1895, 3228 metres of the tunnel were finished, many obstacles having been encountered and overcome, such as water pipes and gas mains. It was necessary to excavate 141,185 cubic metres of earth and 3,014,053 kilogrammes of wrought iron were used in the construction of the tunnel, while the walls required 52,000 cubic metres of beton. The road is 3¼ kilometres long (2¼ miles) of which 3.22 kilometres consist of tunnel and .53 of a kilometre surface road, and has walls one inch thick finished with beton. It is 3¼ metres deep measured from the surface of the street. The inner clear height is 2.65 metres and the clear width 6 metres, thus leaving sufficient room for both tracks and for the necessary iron columns which support the upper portion of the tunnel. The largest grade is one in fifty and the sharpest curves have a radius of 40 metres. The road is double track of standard width, and is provided with loops at both ends. Drain pipes run under each track for the purpose of carrying off all water which may collect in the tunnel. The top of the tunnel is constructed of iron and beton, the I-beams being held together by means of bolts and screws. The columns carrying the roof are four metres apart and rest on foundations of beton.

On the top of the columns, and running lengthwise with the tunnel, are two I-beams each 320 metres deep when supporting a wooden pavement above and 350 metres deep when supporting a stone pavement. These beams also aid in supporting transverse I-beams placed one metre apart, the opposite ends of which rest on the side walls of the tunnel. These transverse beams vary in height according to the required carrying capacity, and they are either 300, 320 or 350 millimetres deep. The intervening spaces between the cross-beams are filled with beton, an extra layer of which increases to 10 centimetres in thickness, and is put in for the purpose of obtaining a slight curvature on the pavement above. The whole tunnel is completely surrounded by layers of asphaltum-felt plate for the purpose of making it completely water-tight. Gas and water pipes which were met with during the process of construction were partly run below the rails and partly alongside the tunnel.

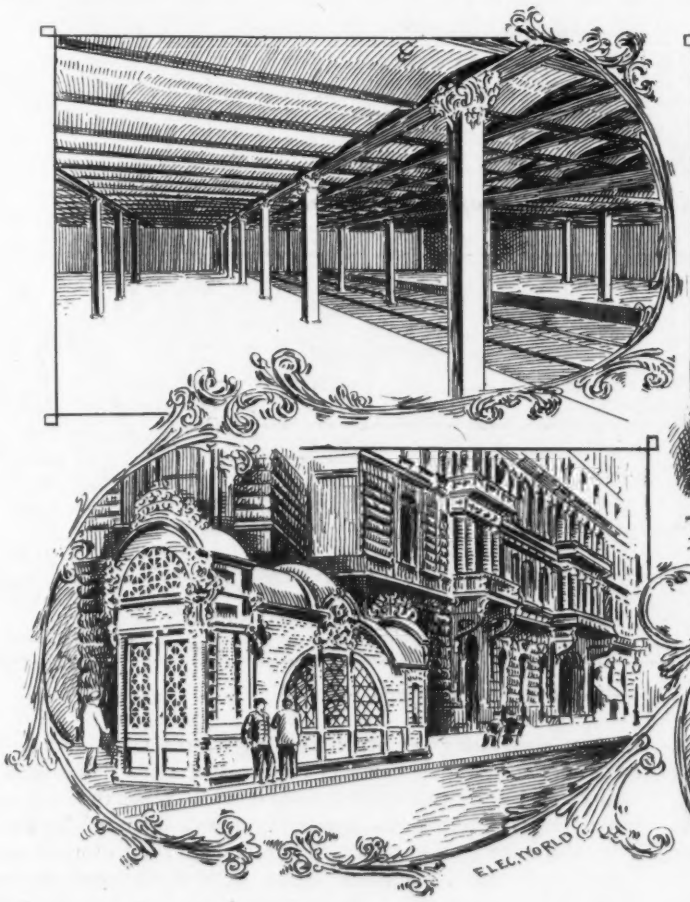


FIG. 1.—VIEW OF TUNNEL AT A STATION.
FIG. 3.—AN ENTRANCE TO UNDERGROUND STATION.

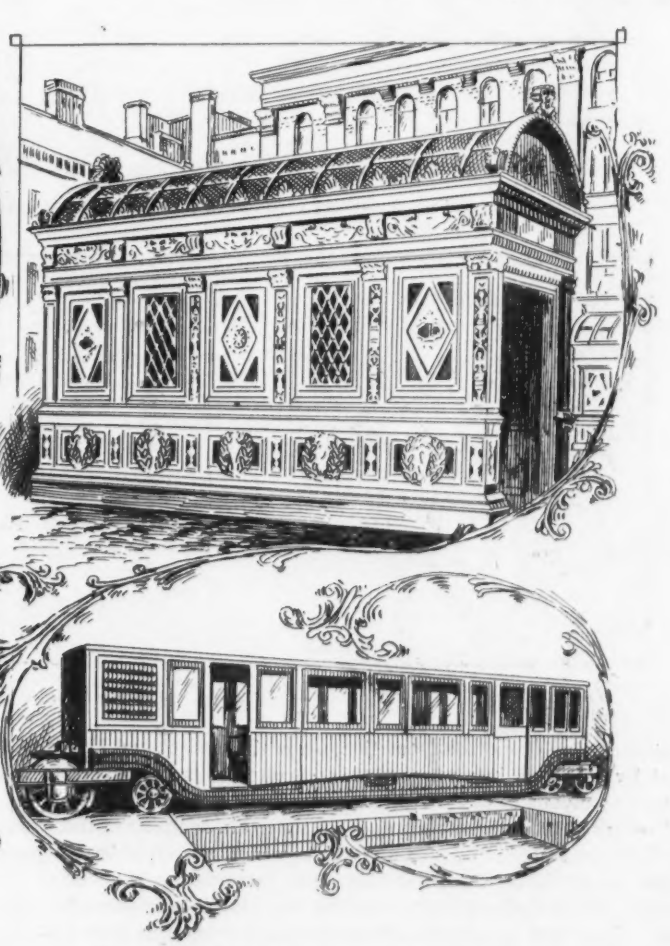


FIG. 2.—AN ENTRANCE TO UNDERGROUND STATION.
FIG. 4.—TYPE OF MOTOR CAR.

II.—STATIONS.

The entrances to the stations of the electrical underground road consist of small but elegant pavilions built in the Italian-Renaissance

style. Two views of these entrances are presented in Figs. 2 and 3. These pavilions have a floor space of 24.22 square metres, being 8.47 metres long and 2.86 metres wide The height is 5.24 metres. The station platform is 3.2 metres below the surface of the pavement. To it lead 21 steps each 15.13 centimetres broad and 1.5 metres wide. The light comes both from above and from the side. Incandescent lights are used at night. The stations of the road are like most of the stations of the city road in London, the platforms being on either side of the double track, so that each platform serves for trains running in one direction only. There are no platforms between the tracks. The stations are about 300 metres apart and have a floor space of 3 x 20 metres and are each lighted by 12 incandescent lamps.

III.—LINE FEEDERS AND CONDUCTORS.

The road is supplied with current from the central station of the electric surface roads, a complete metallic circuit being used. The conductors are supported from the roof of the tunnel and above each track by means of insulators so that the current is conveyed to the motors by means of devices fastened to the car roof of the motor car, and returned through similar devices. Certain sections of the working lines are supplied by special feeders which consist of bare copper cables run along on insulators likewise fastened to the roof of the tunnel. Special circuits are provided for illumination and for signals. There are besides telephone circuits connecting each station. The tunnel is illuminated by electric lamps placed 10 to 15 meters apart, each lamp being provided with a double reflector.

IV.—TRAIN EQUIPMENT.

The passenger cars shown in Figs. 4 and 5 are built of such height as to utilize to the best advantage the height of the tunnel. They were accordingly constructed so that that part of the car in which the passengers are seated is supported by the two trucks placed at each end of the car body. These trucks carry the motors and above them is located the motorman's cab containing the controller, braking and other necessary devices. Ventilation of the tunnel is effected by means of blowers driven by electric motors.

The tickets are sold at the stations and are collected by conductors on the trains, the fare between each station being 20 heller. The speed is 20 to 25 kilometres (12 to 15 miles) per hour. The entire distance of the route including stops is made in about 10 minutes, so that the ventilation of the tunnel is greatly improved due to the rapid movement of the trains.

The power-house contains at present four boilers having a combined heating surface of 268 square metres and two sets of engines of 600 horse-power each, driving multipolar generators.

The rolling stock consists at present of 20 motor cars and 10 trailers, each being 12 metres long, 2.2 metres wide, and having 28 seats and a standing capacity for 18 passengers The motor cars have on each of the two trucks a 50-hp motor. When the road was first put in service automatic speed regulators operated by means of solenoids connected to the brush terminals of the motors on each car were used, their operation being dependent upon the counter E. M. F of the motors. This arrangement, however, did not work satisfactorily, and owing to objectionable sparking has been discarded and hand regulators substituted.

The cost of the road was about 3,500,000 florins ($1,250,000), and has carried up to the present time 10 passengers per car kilometre, the receipts per day amounting to 180 florins ($5.)

In conclusion it may be said that the public has taken favorably to this underground road, a fact largely due doubtless to its smooth and noiseless working and very neat equipment.

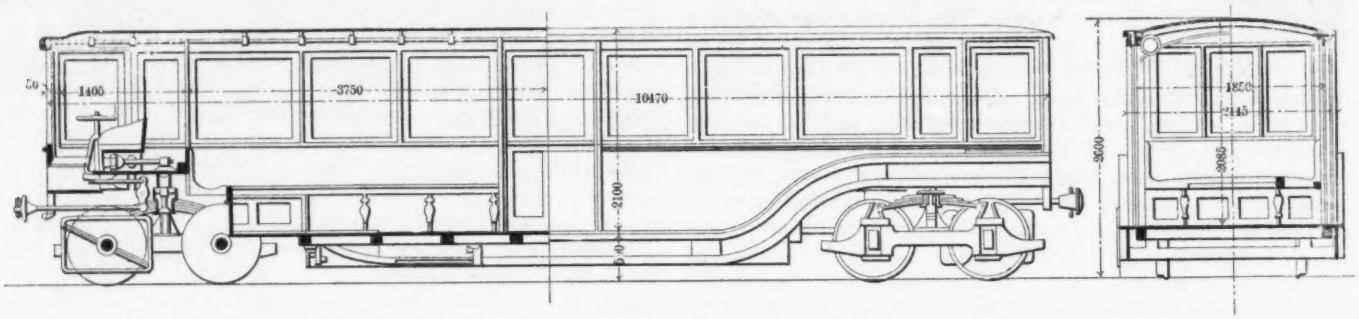


FIG. 5.—TYPE OF MOTOR CAR, BUDAPEST UNDERGROUND ELECTRIC RAILWAY—DIMENSIONS IN MILLIMETRES.

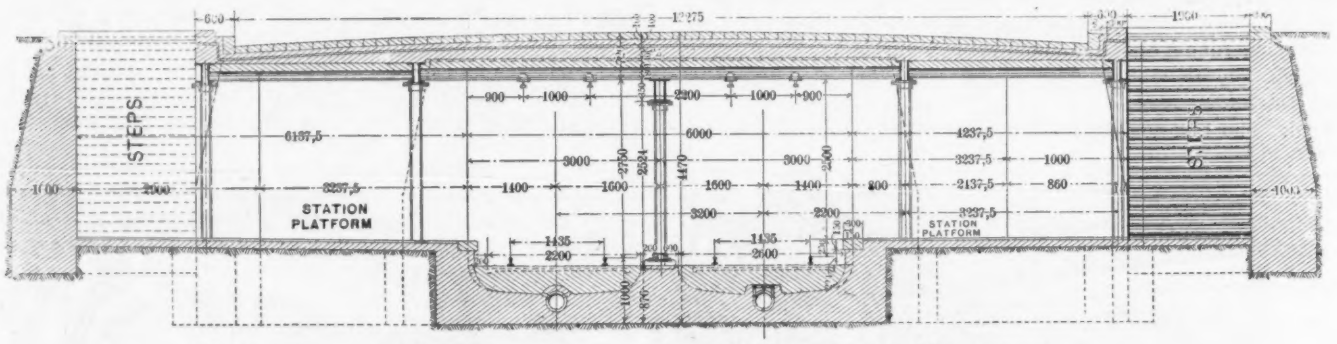


FIG. 6.—ELEVATION VIEW OF TUNNEL AT A STATION—DIMENSIONS IN MILLIMETRES.

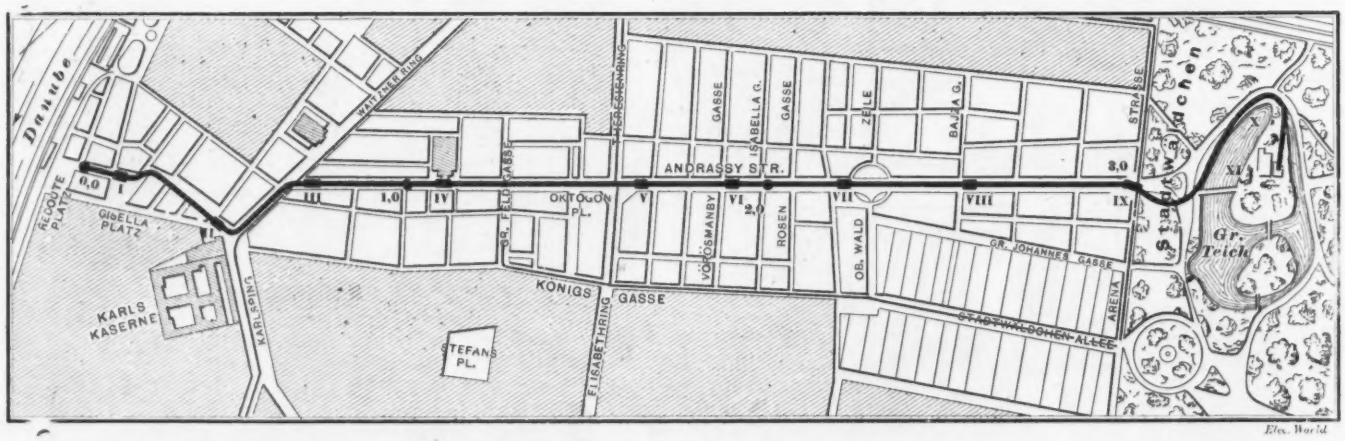
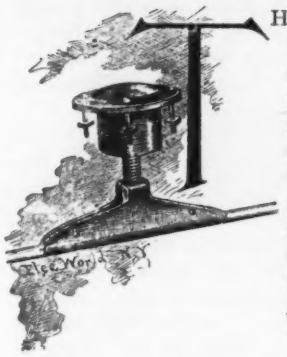


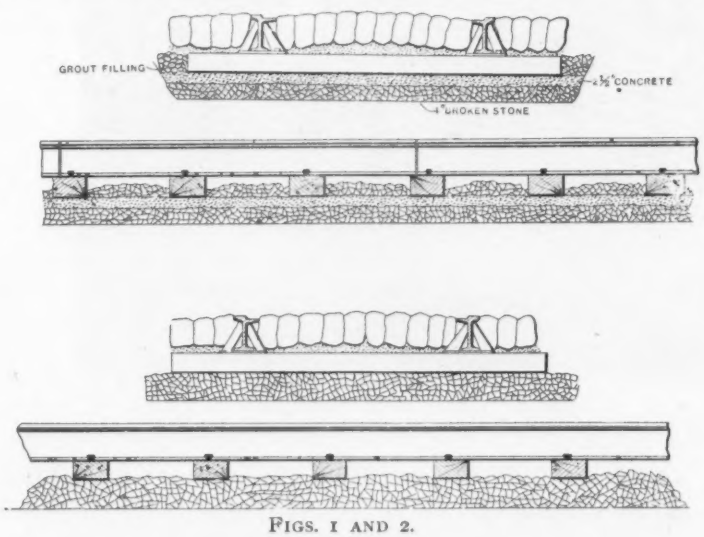
FIG. 7.—MAP OF ROUTE OF BUDAPEST ELECTRIC RAILWAY.

Electric Railway Construction.

BY ALBERT VICKERS.



THERE is hardly a department of human activity where such marked and rapid changes and improvements have been seen, as in the electric street railway field. We have bought and constructed each year the best there was, believing that we were providing for a reasonably few years at least, only to find the following year so far ahead of our calculations that we gave up standardizing on the old lines, extended and improved on the new, and bolstered up our sinking fund with a view to eventually standardizing. The result has been a great many experiments, and a lot of "hash," out of which disorder we are at last bringing some semblance to our ideal. One feature of street railway, as of most improvements, has been a general and consistent tendency toward simplicity. We are discarding line shafts, and even belts. We are coming down off chairs, once the "bêtes noire" of the railway man's existence, and discarding the not quite so uncertain, but equally troublesome tie-rod. We have substituted two gears for four, and have tried the gearless, to return to the single reduction, having found that in spite of its seeming simplicity, it was through its clutches, and inefficiency, and general mechanical complications, too impractical for ordinary street railway business. So radical have been all these changes, from the ballast to the trolley-wheel, that there is hardly any part which three years ago was in use, that is considered economical, or even possible, practice to-day. Of course one great feature of the change from old to new, is the considerable outlay required to keep abreast of the times, and the fact that the majority of our roads have been able to reach this without the receiver's aid is a considerable argument in favor of street railway investments. A good example of the absorption of capital in this was in the case of a large road running at the time by horse-power. About five years ago they took up the flat tram rails, and with a view to equipping with electricity, a 66-pound girder-rail was laid on chairs in the best possible manner and paved. Within a few months they began to negotiate with parties for a sale, which was completed within the year, and by the time the road changed hands, and before electric cars had been run on it at all, the road-bed was so far behind the times that it was condemned, and arrangements made to relay it.



FIGS. 1 AND 2.

A great many of our roads made the mistake of trying to operate on an insufficient road-bed, thus trying to save in first cost, but only to learn by bitter experience its effects on operating expenses. Poor returns, meagre dividends and an occasional receivership, due mainly to ruinous operating expenses, have made capital timid. Where we could bond from $20,000 on suburban roads to as high as $80,000 a mile on city properties, we have difficulties in disposing of issues at half these amounts. It becomes, therefore, all the more the duty of the engineer to show capital that we are able to profit by our past experience, and that we have arrived at a clear understanding of present needs. and as far as possible to anticipate the needs and developments of the future, thus rendering street railway properties by their permanence and economy what they should be —the best paying properties in the country.

As it is not possible to do justice to all the various departments at this time, we will therefore confine ourselves in this article to the most important of them all, and that upon which the economy of all the rest of the apparatus depends, consequently the dividend-paying power of the road. It is easier to obtain good results with poor apparatus on perfect track than with the best apparatus on poor track. The standard road-bed to-day in most of our cities consists of a 90 to 95 pound girder rail of slightly varying section and usually grooved, the latter an item generally insisted on by the city, of questionable benefit to them, and of positive detriment to the railway company. Ties are of oak, cedar or chestnut, usually 5 x 8 inches x 8 feet, spaced from two feet to two and one half feet centres; foundation consisting of six to eight inches of broken stone ballast below ties, tamped with broken stone and filled to top of tie with same.

Many of our largest roads have done away with tie rods and are using a malleable iron double brace plate, spiked to the tie, with excellent results. These brace plates offer no obstruction to pavement, and hold the rail more securely than the rods. They are usually placed on every second or third tie, but in cases of extra

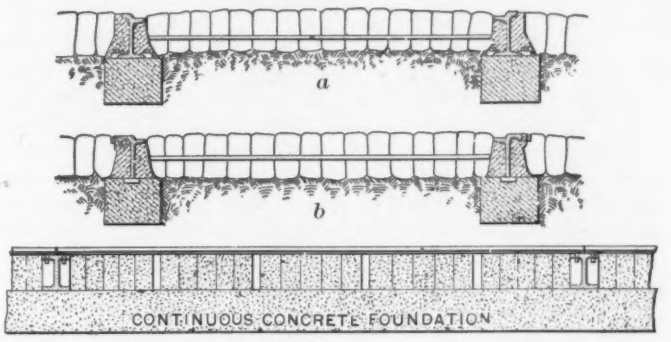


FIG. 3.

heavy traffic, may be placed on every or every other tie. Joints are for the most part made by two 30-inch 12-bolt angle bars.

Now, as already stated, we have run rapidly up the scale of weights in the past few years. Is it therefore safe to believe that we have come to the limit in that direction? It is the writer's belief, that as far as the rail itself is concerned, that the present weight is and will be ample for anything approaching the present weight of equipments. In spite, however, of the great weight of rail, the results of the past year in some cases have made us feel that there was room for improvement somewhere, and that the road-bed was not quite as durable as we had hoped.

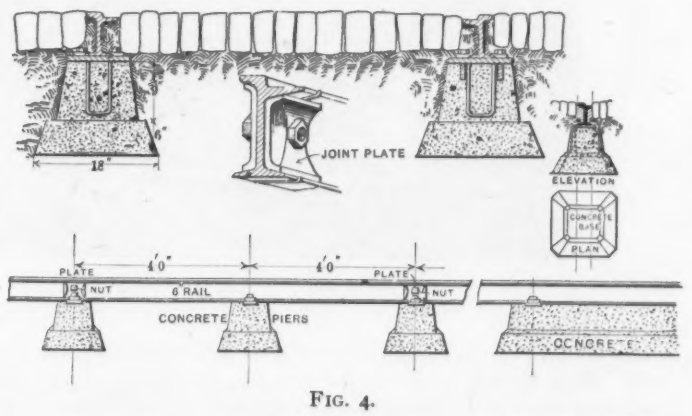


FIG. 4.

Assuming that the future is provided for in the weight of the rail and knowing that the ties cannot effectively be placed closer than two feet, we have only the foundation left to consider, and in which there seems to be some room for improvement. Take the standard method of laying a 90-pound rail, (Fig. 2). A 20-inch excavation is made and the bed is rolled with a steam roller; six inches of broken stone are then put in and rolled in the same way; ties are distributed, spaced and spiked to the rail, and then the rail is jacked to grade, and filled and tamped with broken stone; and right here, in nine cases out of every ten, the trouble begins. Under a 60-foot length of single track ties 5 inches by 8 inches by 8 feet, and 30 inches between centres there are 128 square feet of supporting surface. If

the broken stone is thoroughly and perfectly tamped under every tie we find by careful examination that less than 60 per cent. of this surface will be in actual contact with the stone; but it is well known that there is nothing much harder to get thoroughly done than tamping—particularly with broken stone—and out of the possible 128 square feet we are fortunate if we get from 50 to 60 square feet of actual bearing.

After the track has been used a short time we are not sure of as good results in this. As an example, the writer has tested ties as soon as tamped, by the simple method of striking with a bar where the ties all sounded fairly solid; which after a few days of traffic, and repeating the test showed several to have lost the solid sound, indicating that they were not properly tamped, and that a certain movement had taken place in the stones. A very small fraction of an inch is sufficient to weaken the substructure, and eventually to tend to throw the track out of line. Of course such things always grow worse instead of better. The 128 square feet of surface is certainly sufficient to support properly 60 lineal feet of track, but it is equally certain that the whole 128 feet, if possible, ought to be utilized, and in such a way that each square inch supports equally with every other square inch, and a uniform, solid support given to every part of every tie. If we could surely obtain such results throughout every part of our track, we would have a permanent return for our investment, and have built for many years to come. It is impossible to obtain perfect results by tamping alone, as it is impossible to tamp equally solid every tie under a section. This, no matter how solid the track seems at first, is a manifest weakness, and will militate against the life of the road-bed. We are approaching perfection when we put a solid, and equally solid, and uniformly distributed support under every square inch of supporting surface. This result is obtained in the concrete foundation and road bed, in use in Montreal, and which has produced the most solid and durable construction in the world. While the Montreal work is done at great expense it is possible to approximate its perfection without greatly increasing the present cost, in the following manner:

Prepare the excavation to the depth of 21 inches and roll with the steam roller, fill in 4 inches deep with broken stone and again roll well. Next spread 2½ inches of concrete, consisting of two parts sand, five parts of broken stone and one part natural cement. This concrete layer should be brought as nearly as possible to within 14 inches of grade; when the ties and rail are in place and spiked the rail is carefully lined and surfaced, lightly tamping with a small quantity of gravel to bring it into line and keep it there. Then a layer of broken stone being thrown in between ties, a clear grout of one part natural cement and two parts clean, sharp sand is poured under the ties, which should be from one half inch to one inch above the concrete bed. When this is set the spaces between the ties are filled up with broken stone and gravel ready for paving. The result is that every tie becomes an equal support, and it is almost impossible for the rail ever to move (see Fig. 2). Every unevenness is filled in, and a smooth, solid uniform bearing provided under every portion of the tie, giving a rigid and permanent road-bed in every respect. The cost of such construction is only a trifle more than the above described broken stone, there being only 324 cubic yards of concrete, per mile at an increased cost over broken stone of about $1 and from 30 to 35 yards of grout at a cost of about $4 per yard. This increased cost is not to be considered as against the great advantage possessed by this method. Where the ground is soft, concrete should be used entirely for the foundation, and ties filled in.

It may be of interest in this connection to notice a new system of track construction, called the Hevner system, which involves the above principles of uniform support. The inventor goes a step further, however, and does away with ties, and gives his rail a continuous support. Fig. 3 gives an idea of what is called the city construction. As is evident from the diagram, no ties are used, and gauge is maintained by tie rods, as shown, in place of ties. A continuous bed of cement is laid, square section, dimensions 12 inches by 12 inches, and running under the rail. Where the rail is put in place and set to gauge, blocks of cement of section to fit each side of the rail are built in, filling with cement, as bricks in a wall forming an additional support for the rail, and leaving smooth surfaces to pair to. The rail is practically set in cement from top to bottom. This can be used with standard rail sections, as shown in Fig. 3*a*, or can be used with an adjustable rail, as shown in Fig. 3*b*. This rail is set in the same construction and foundation, except that the rail has no base, but rests on a flat strip of iron set into the top of the square foundation. At reasonable distances iron angles are set into the cement, to which the rails bolt. It will be seen that by removing the screws the whole rail can be taken out, and another replaced without disturbing the surrounding setting or pavement, thus obtaining it is claimed a substructure that will last forever. For light suburban construction it is proposed to set the rail on piers at intervals of four feet, and these piers in case of soft or boggy ground can be made as deep and of as great base area as desired. (Fig. 4.) It is possible by the use of these piers to be independent of the irregularities of the ground, doing away with the necessity of grading in many cases. The rails are bolted to iron straps set in the piers as shown in Fig. 4; the principal claim, however, is made for the city or continuous construction.

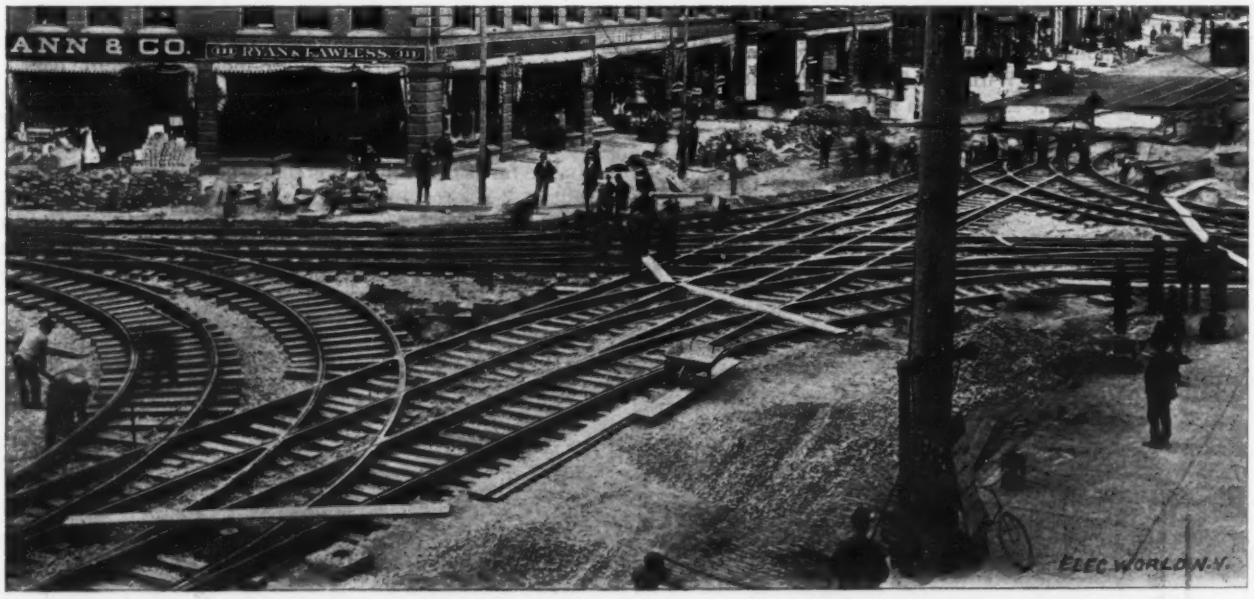


Fig. 5.—Track Construction at Syracuse.

The doing away with ties is a radical move, and one that will be watched with interest. It is probable that several miles of this system will be put down this season, which will give us a chance to study it from a practical standpoint. I show a photograph of a fine example of the best modern railway construction, in the form of a piece of special work, nine-inch girder. It is one of the finest pieces of special work ever laid within the radius of 200 feet. There is over 1800 lineal feet of railway, and the whole piece weighs about 180,000 tons; for the foundation and ballast about 120 cubic yards of broken stone was used. This piece is to serve as the common centre of the Syracuse street railway lines, and will experience heavy service, as all the cars in the city pass over it.

The Heilmann Locomotive.

BY H. WARD LEONARD.

ABOUT two and one half years ago the first experimental Heilmann locomotive, "La Fusee," ran successfully about 1200 miles under test on the Western Railway of France. This being the first long-distance work ever done by a locomotive propelled by electric motors up to even this time, it would seem as if this locomotive were deserving of careful attention, for all observers of the progress of electrical development must be impressed with the lack of progress in the line of electric locomotives which would be comparable with the modern steam locomotives as to speed and traction. In December, 1894, the writer carefully examined the original Heilmann locomotive "La Fusee," and on Feb. 27, 1895, described the locomotive before the American Institute of Electrical Engineers. Upon the completion of the tests upon "La Fusee" ("The Rocket"), which were conducted under the direction of the chief engineer of traction of the Western Railway of France, the construction of two larger locomotives was undertaken, the exact tests upon the former enabling the makers to design the new locomotives so as to secure exactly the desired result. These two large

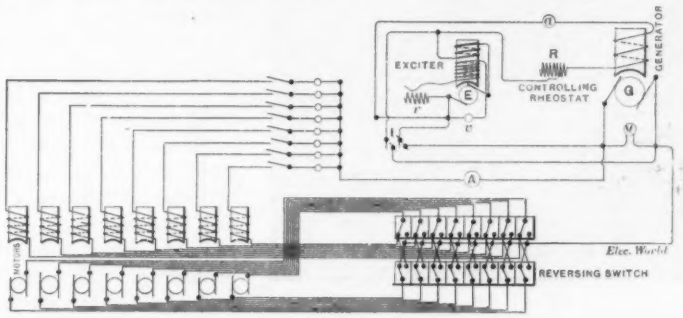


FIG. 1.—METHOD OF CONTROL.

locomotives will be tested very soon, and hence a general description of the type may not be out of place at the present time. The Heilmann locomotive has eight pairs of drivers, as shown in the elevation view in Fig. 3, each of the eight axles being driven by an electric motor. There are two trucks, each having four axles, as shown in Fig. 5. The drivers are not mechanically coupled in any way. Resting upon two pivots, one at the centre of each truck, is a rigid platform made of steel beams. The platform rides entirely on springs, the trucks being equipped similar to Pullman car trucks. Upon the platform is placed a boiler, a steam engine and a dynamo. The steam engine, supplied by the boiler, runs continuously and drives a generator, which is direct-connected to the engine shaft. The generator supplies current to the electric motors on the driven axles.

The electric generator and motors supply in effect an electric power-transmission variable gear. In the ordinary locomotive the connecting rod transmits the power from the piston to the rim of the driver, which, however, does not act as a variable gear. If we had on a steam locomotive a set of gears enabling us to secure any reduction of speed desired with a corresponding increase in pull, just as we do on a machine lathe, it would evidently be a very important improvement, and many attempts at differential mechanical gearing between the piston and the driver of the steam locomotive have been made, but thus far with unsuccessful results.

The Heilmann locomotive secures all the advantages that such a gearing would give and in addition secures for its drivers that smooth, rotary pull or torque which is one of the chief advantages possessed by electric motors over all forms of reciprocating motors.

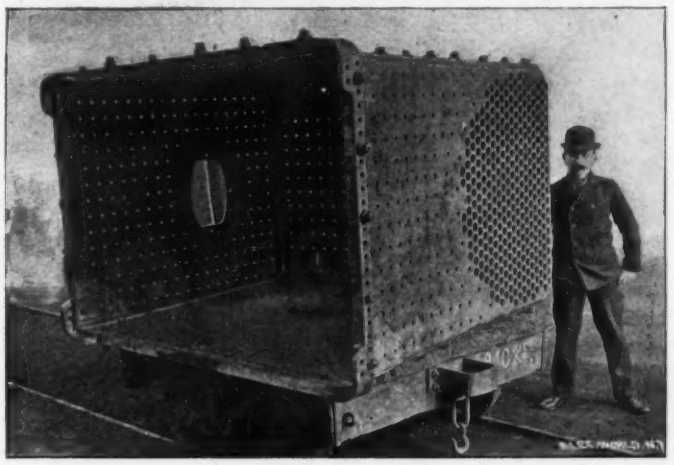


FIG. 2.—FIRE BOX.

In the *Bulletin* of June, 1896, of the Société des Ingenieurs Civils de France, Mr. M. F. Drouin, Mr. Heilmann's chief engineer, has given some very interesting figures as to the test on "La Fusee," and also as to the leading features of the design of the two locomotives soon to be tested, and the figures which I shall hereafter give are taken from Mr. Drouin's paper. "La Fusee" developed at the rims of the drivers 450 horse-power while running at 62 miles an hour (100 kilometres). The power at the draw-bar was slightly less

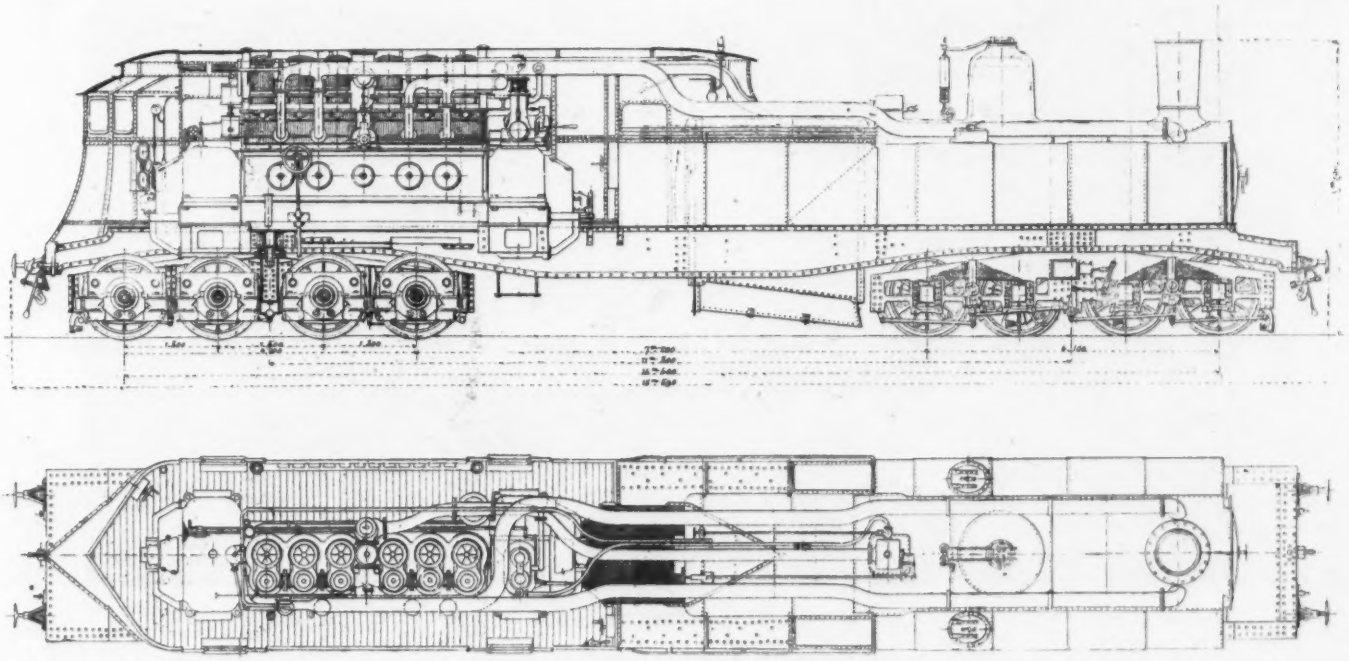


FIG. 3.—ELEVATION AND PLAN OF LATEST TYPE OF HEILMANN LOCOMOTIVE.

than 200 horse-power. It would start upon a sharp curve 420 tons. It was found impossible to skid the wheels, this being due both to the uniform pull and the enormous adhesion of the 16 drivers carrying the entire weight of 115 tons. The dynamometer car of the Western Railway was used for these tests and the curve of draw-bar pull when compared with that of the steam locomotive shows, as would be expected, a very uniform pull for the Heilmann locomotive and a very fluctuating pull for that of its steam contemporary. It is worth noting, in passing, that the Heilmann locomotive, with the exact measuring instruments and tachometers, presents perfect facilities for studying all the questions of speed, torque, horse-power, etc., which enter into electric traction problems. The maximum observed speed of "La Fusee" was 67 miles (108 kilometres) per hour on a level. The test lasted over a period of many days, and it was found that the efficiency of the locomotive materially improved as its various bearings got in perfect working condition, as might have been expected.

In a report made upon the Heilmann locomotive by the Western Railway of France and read at the Railway Congress in London in 1895, it is stated that the coal consumption in a run from Paris to Mantes was 20 pounds of combustible per mile (5.6 kg per km), and that while on the first day of the test the consumption of coal (combustible) was 24.5 pounds per mile, it fell during the test, so that upon the last day it was only 13.2 pounds per mile. Including the weight of the locomotive, the consumption of coal was .13 of a pound per ton mile and .32 of a pound of coal was consumed per mile per ton hauled by the draw-bar. In the new locomotives the weight is 115 tons each when normally loaded. Willans engines, especially designed for the service, are used, there being six cranks for the purpose of securing the most perfect balancing of the engine, so that it shall not cause any vibration upon the platform. The normal full speed of the engine is 450 revolutions per minute. The generators and motors were made by Brown, Boveri & Co., of Baden, Switzerland.

There are two six-pole generators, identical with each other, one at each end of the engine shaft and electrically connected in parallel. The combined output of the dynamos is 2000 amperes at 455 volts, with a possible output of 4000 amperes for a short period.

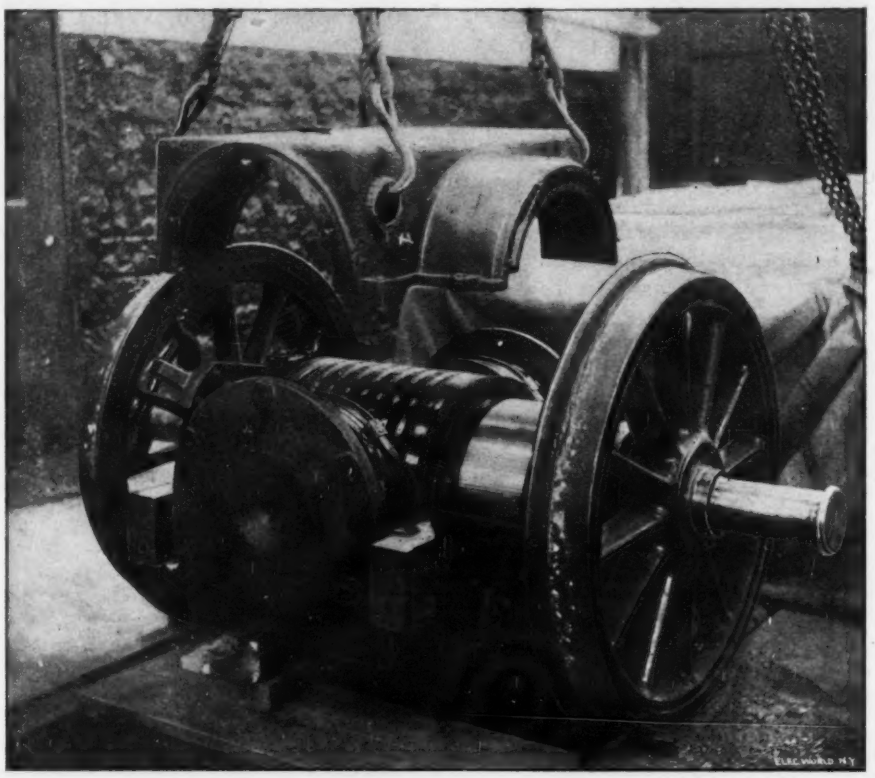


Fig. 4.—Method of Mounting Motor.

The ordinary French locomotive boiler is used and is shown in Fig. 10. Its principal dimensions are:

Grate surface, 36 square feet (3.34 square m).

Heating surface of fire box, 177 square feet (16.47 square m).

Heating surface of the tubes, 1818 square feet (169 square m).

Total interior heating surface, 3245 square feet (185.47 square m).

Number of tubes, 351.

Exterior diameter of tubes, 1.77 inches (.045 m).

Length of tubes between heads 12.46 feet (3.8 m).

The field circuits of both generators and the eight motors are separately excited, the separate two-cylinder Willans engine and four-pole dynamo of 28 horse-power being operated for this purpose and also for the purpose of supplying the electric lights on the train. The eight motors each have a normal rated capacity of 125 horse-power at 62 miles (100 km) an hour, which corresponds to a torque of 748 pounds (340 kg) at the rim. The maximum torque at the rim for one of these motors under test was 2640 pounds (1200 kg). The diameter of the driving wheels is 45.67 inches (1.16 m).

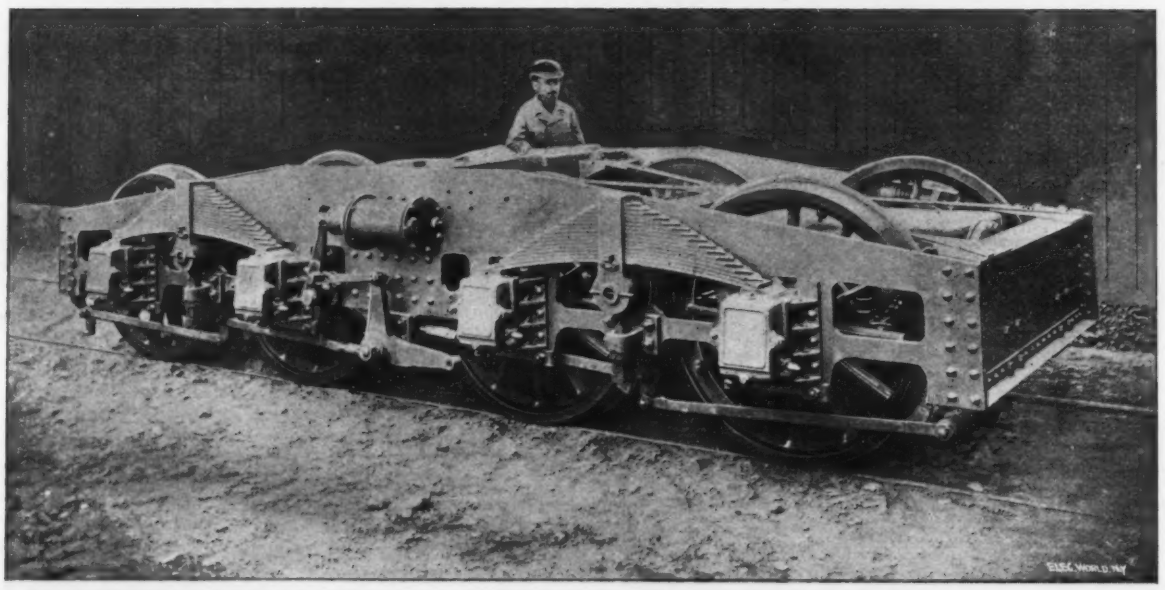


Fig. 5.—Type of Truck.

The motor armatures are all in multiple with each other across the terminals of the generators, but there is a commutator in the circuit leading to the motor armatures, by which they can be grouped in two series of four each when it is desired to secure the greatest tractive effort and slow speed. There is also a reversing switch in

this armature circuit for the purpose of reversing the direction of the current through the motor armatures.

The motors are four-pole and are central upon the shafts, that is, the shaft passes through the centre of the sleeve carrying the armature, the axle being driven through a spider, practically as in the case of the Short gearless motors.

The Heilmann locomotive has the following general dimensions:

Length between buffers, 52.12 feet (15.89 m).

Total length of platform, 50.5 feet (15.4 m).

Length of truck, 13.45 feet (4.1 m).

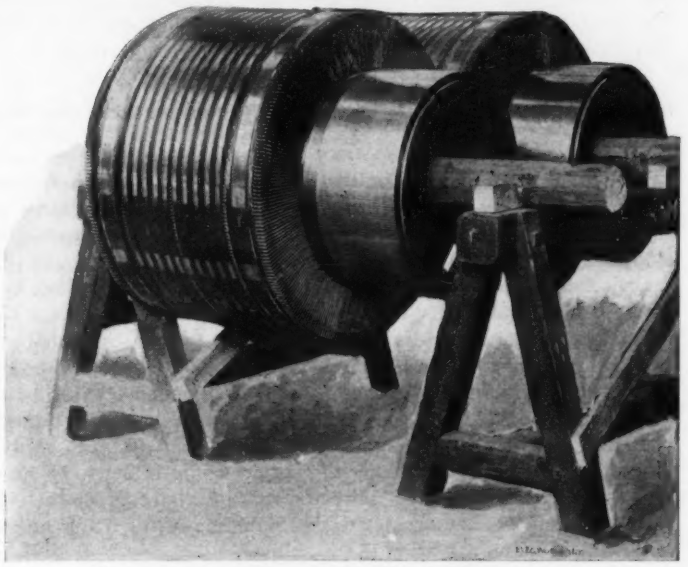


FIG. 6.—GENERATOR ARMATURES.

Distance from axle to axle between the two trucks, 37 feet (11.3 m).

Width of platform, 8.8 feet (2.7 m).

Height of stack above rail, 13.7 feet (4.19 m).

The indicated horse-power at the engine cylinders is 1350. The efficiency of the steam engine is 90 per cent., that of the generators 95 per cent. and of the motors 90 per cent. Allowing 2 per cent. for loss in the conductors between the generators and motors, the efficiency would be 75.4 per cent., which is the ratio between the power at the rim of the driver and the power indicated in the steam cylinders. This means that there will be at the rims of the drivers available for continuous duty 1000 horse-power.

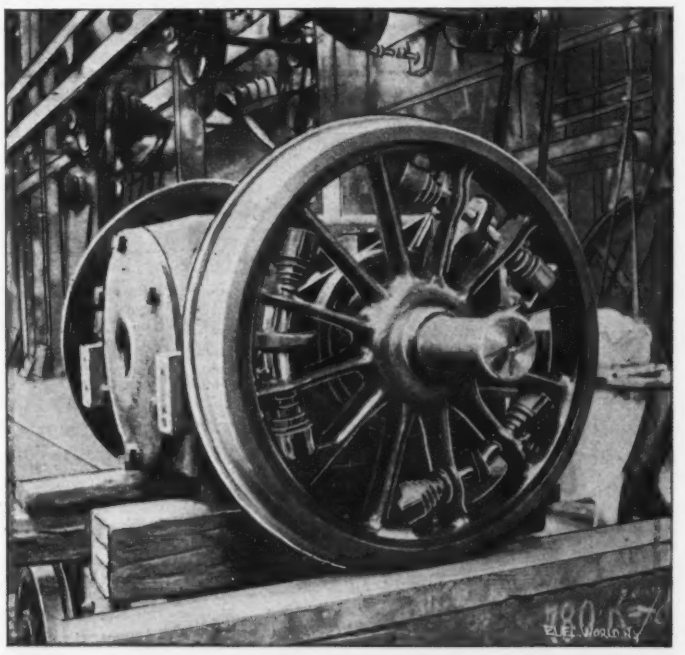


FIG. 7.—METHOD OF MOUNTING MOTOR.

When operating at 62 miles per hour on the level track the available pull at the draw-bar will be 3900 pounds (1776 kg), which will haul 355 tons. The useful work at the draw-bar will be 657 horse-power, which means an efficiency between draw-bar pull and indicated power in the engine cylinder of 47.1 per cent., when operating at 62 miles per hour and hauling 355 tons. So much for the figures as presented in Mr. Drouin's paper.

In order to compare the figures of the Heilmann locomotive with similar figures on ordinary steam locomotives, I quote the following: "Careful experiments made in France by the Eastern Railway showed an efficiency for a locomotive having four wheels coupled, of 43 per cent., and tests by the Pennsylvania Railroad Company taken at 65 miles an hour showed an efficiency of 42 per cent. *Locomotive Engineering* of June, 1893, gives the record of a test upon a locomotive drawing the Empire State Express. This test showed that with 304 revolutions per minute for the drivers, which gave a speed of 70.5 miles an hour, the indicated horse power in the cylinders was 977. The locomotive is of the eight-wheel type, that is, four coupled drivers each 78 inches in diameter, the cylinders being 19 x 24 inches. The heating surface of the fire-box is 150.8 square feet; of tubes, 1670.7 square feet; of boilers, 1821.5 square feet. The grate area is 27.3 square feet and there are 268 tubes, the outside diameter of which is 2 inches.

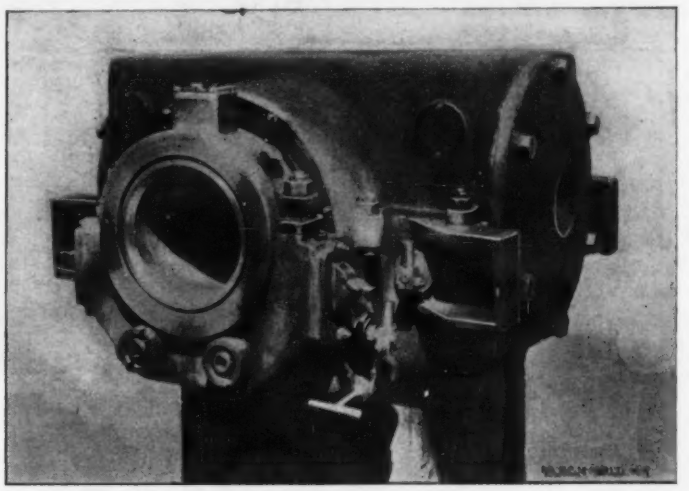


FIG. 8.—EXTERIOR VIEW OF MOTOR.

The train hauled consisted of four coaches weighing about 340,000 pounds. The locomotive and tender weighed about 200,000 pounds, making the total weight of the train 270 tons. In accelerating the train a card taken at 37 miles an hour showed a mean cylinder pressure of 59 pounds. At 60 miles per hour the mean cylinder pressure was 40.7 pounds. At 70 miles per hour it was 47.6 pounds. Seven pounds of water were evaporated per pound of coal.

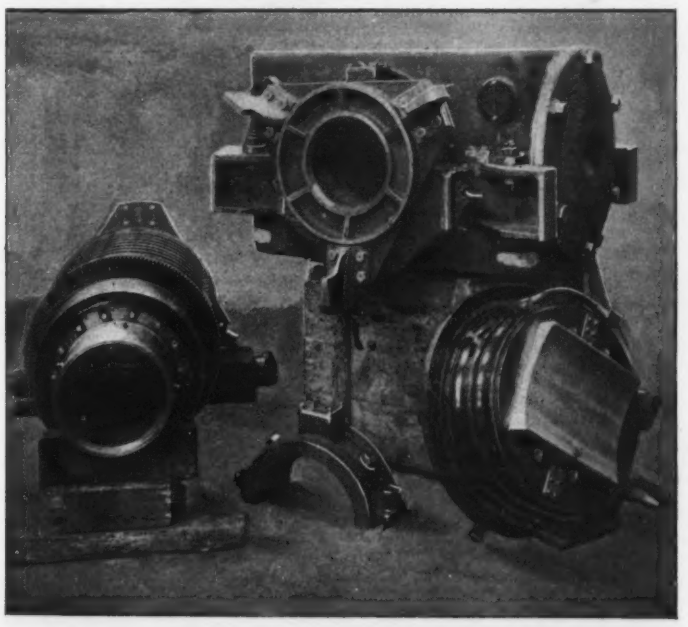


FIG. 9.—EXTERIOR VIEW AND PARTS OF MOTOR.

A trip from New York to Albany showed a consumption of coal

at the rate of three and one eighth pounds per horse-power per hour.

The highest power recorded as indicated in the cylinders was 1120 horse-power.

It will be noted in comparing the Heilmann locomotive with the above, that it has theoretically a greater indicated horse-power, higher efficiency, greater adhesion and less coal consumption.

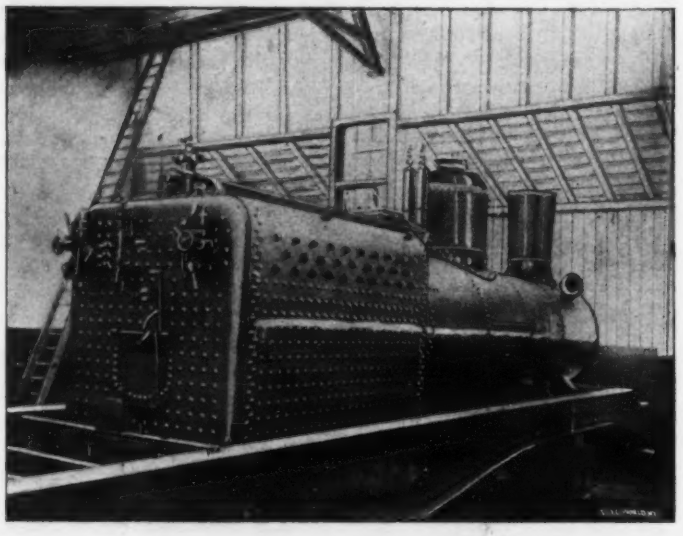


Fig. 10.—Boiler and Mounting.

As to whether the Heilmann locomotive will be able to compete with the ordinary steam locomotive will of course be a question of first cost, operating cost and maintenance, and many years may be required before a conclusion can be positively reached.

But there are many cases where the ordinary locomotive is a veritable nuisance daily to many hundreds of thousands of people, where the Heilmann locomotive seems to offer a speedy and

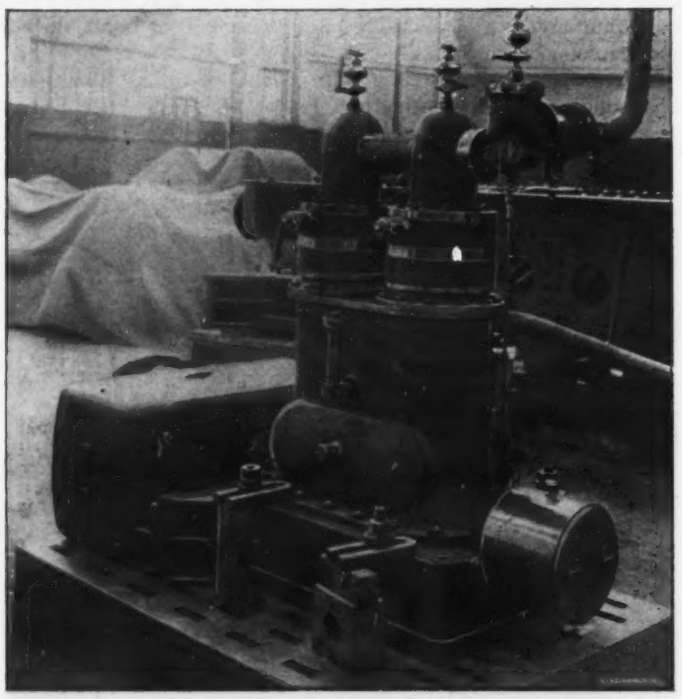


Fig. 11.—Exciting Dynamo and Engine.

perfect relief. I refer to the tunnels about New York City and similar cities and the switching engines used in the hearts of our cities.

All persons who have experienced the nuisance due to the switching engines of the New York Central Railroad in the vicinity of Columbia College, and all who have traveled through the tunnel of the New York Central and the Delaware, Lackawanna & Western and other roads can appreciate what advantage and relief would be gained by substituting for the snorting, shrieking, rattling switching engines a practically noiseless locomotive, and those who are obliged to endure the smoky, stifling, sulphurous atmosphere of our tunnels can imagine the improvement which would be effected by the use of a locomotive in which the combustion of the coal can be made practically perfect and which will therefore make practically no smoke. An electric locomotive operated by a moving contact of any kind for switching purposes in the yards of the New York Central Railroad would involve an almost prohibitive complication of circuits, switches, etc., and also a much greater cost than the equivalent Heilmann locomotives would necessitate. In the case of an electric locomotive for tunnel work, I think it will be evident to any one who is familiar with the installation at the Baltimore tunnel that the Heilmann locomotives will be cheaper, simpler and more flexible, while equally effective.

Note on the Pressure of the Trolley Wheel Against the Wire.

BY HERMANN S. HERING.

While making some tests on the losses in trolley and rail contacts it was observed that the pressure of the trolley wheel against the wire was a very important factor in producing or preventing the sparking, and varying the losses resulting therefrom.

Questioning revealed the fact that little or no attention had been paid by superintendents to the tension of the spring in the trolley base, except to prevent its being very loose or very tight. It was usually allowed to remain as originally adjusted, except an occasional tightening when it got too loose. Only one mechanic of the many interviewed had noticed any connection between the pressure of the trolley, its sparking and its liability to jump off. He said he had often found that tightening the spring would remedy the sparking of a trolley sent in for repairs and that he tried to keep the pressure uniform. No one else connected with any of the roads seemed to have paid much attention to the subject.

Some tests were undertaken on four prominent roads and measurements made of the pressure of the trolley on over 100 cars. In a preliminary test it was determined that although sparking was sometimes caused by a bad wheel, it was more often due to insufficient pressure. Observations were taken with new and old wheels and each would spark with the spring slackened and cease when it was tightened. In order to produce continuous sparking the wheel must be very bad and the spring very slack, but sparking at the hangers occurs at even a moderate pressure, especially when a bad form of hanger is used.

In addition to sparking less, the trolley stays on the wire better with a higher pressure, which is a very important feature especially on curves, switches and cross-overs. This is a natural result as the wire will hug the groove more closely and have less tendency to

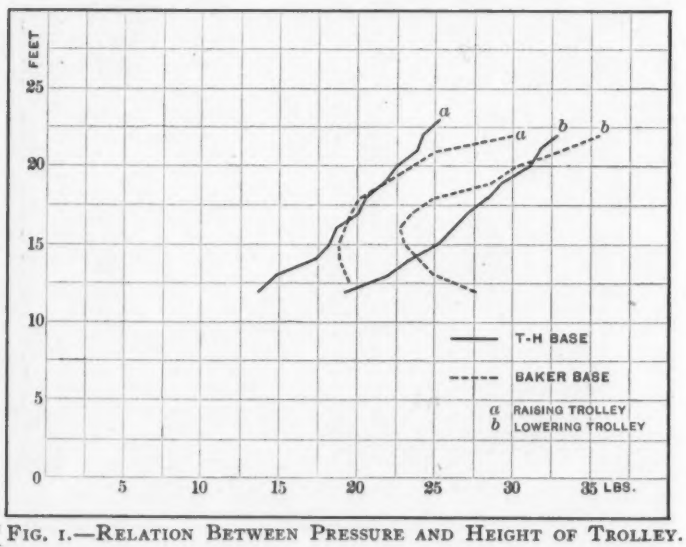


Fig. 1.—Relation Between Pressure and Height of Trolley.

leave it. On some roads in Europe the trolley wire is supported on chains or flexible hangers and the pressure of the trolley made great enough to support and raise the wire so that it virtually rests upon the trolley wheel. This practically prevents any jumping off and sparking and permits smooth, elastic running without the bumping felt with rigid hangers.

It has been claimed that the increased pressure injures the overhead work where the trolley strikes the hangers, cross-overs and switches, but observation has not shown this to be the case except on roads having very poor overhead construction.

Objection was also made on account of the difficulty of getting the trolley back on the wire in case it does leave it. With sufficient pressure it will rarely jump except where the overhead work is defective, and the sooner this is found out and remedied the better.

The tests showed the pressure to vary from 9.3 to 33.8 pounds, and the averages on four lines were from 15.4 to 30.8 pounds, which is quite a wide range. The best results seem to be obtained with a pressure of about 20 to 25 pounds. Less than this renders the trolley liable to jump and spark, and more, makes the trolley unnecessarily difficult to manage. With 10 pounds or less a good wheel is very apt to spark and jump, and a bad wheel almost sure to; even with 15 pounds the liability is not removed. The sparking of a bad wheel with 16½ pounds pressure, for instance, was stopped when the pressure was increased to 21 pounds.

For the last few years the makers of trolley bases have supplied stronger springs, as they have been recognizing the advantages, but the older forms had springs producing from 7 to 15 pounds, as the effectiveness of greater pressure had not yet been recognized.

In addition to those already mentioned, tests were made of the pressure of the trolley at various heights, the difference between the pressure produced when the trolley was raised or lowered, and the difference between the vertical pressure and the force required to pull the trolley obliquely.

The method of making these tests consisted in using a spring balance reading to 35 pounds in quarter-ounces and hooking it into a loop tied in the trolley wire at a convenient height. The balance was then pulled until the trolley just left the wire and a reading taken, each determination being made four times. The observers stood behind the car and pulled the rope so that it just cleared the edge of the roof.

To determine the pull at various heights, a tape-line was fastened to the trolley-wheel and the spring-balance used to pull the rope vertically, but in this case the trolley-base was turned slightly to one side of the car to give clearance to the rope.

The method of weighing the car on track scales, with the trolley on and off, was also tried, but besides not being sufficiently accurate, on account of the value being so small an amount compared with the total weight of the car, this method was too slow and cumbersome.

The difference in pressure between the trolley moving up and moving down is quite considerable, and in making tests this factor must be borne in mind. This difference varies from 3½ to 10 pounds. Fig. 1 contains the results of some tests made on two makes of bases, the T.-H., used by the General Electric Co., shown by solid lines, and the Baker base, shown by dotted lines. Curves marked *b* are the values obtained when pulling the trolley down, and curves marked *a* when allowing it to rise. In the first case the pull is the sum of the tension of the spring and the friction, and in the latter it is the difference, and necessarily smaller. Readings were taken every foot from 12 to 23 feet above the rails. The values gived are for vertical pressure. The height of the trolley wire above the rails varies from 17 to 21 feet, but averages about 19 feet.

The curves show decided characteristics, the pressure in the one steadily increasing with the height, and in the other reaching a minimum at about 15 or 16 feet and then increasing again.

In order to compare the vertical with the oblique pull, the tension of the trolley rope was measured in the two cases, the oblique angle being that produced by the rope just passing the rear edge of the roof of the car. The trolley was 19 feet above the track in all the tests. With a Westinghouse base the vertical pull on the rope averaged 19.8 pounds, and the oblique 18.1 pounds, being 91.5 per cent. of the vertical; with a new Westinghouse base, but slightly used, the vertical pull was 34 pounds and the oblique 31.5, 92.7 per cent; with a Baker base the vertical pull was 19.5 and the oblique 17.9 pounds, 92 per cent. The T.-H. base gave the same result as the Baker.

Table I contains the pressures determined on 101 cars. Many more tests were made, but these are given as being typical. Each value in the table is the mean of four readings. The tests on any one road were made on the same day, the observers being stationed at the terminus and making the measurements during the lay-overs. The values given are the pressures perpendicular to the wire.

With the Westinghouse bases the pressure varied from 16.9 to 33.4 pounds mostly from 17 to 22, and were somewhat irregular, the average being 21.6 pounds. The cars giving high values of 30. pounds and over had new equipments or new springs. Cars Nos. 210 and 225 had new bases and No. 215 had its spring tightened. The conductors on this line favored a pressure of about 21 pounds. With less than this they had trouble with the trolley jumping off, and more, made it hard to put the trolley on if it did jump off, which seldom occurred.

On the cars having a new equipment of Westinghouse bases the pressure varied from 24.5 to 33.8 pounds; only two readings were below 30, the rest being very uniform. The average was 30.8 and the conductors complained of the tension being too strong. The trolley seldom jumped off, however.

On the cars using the Baker bases the pressure varied from 11.3 to 21.9 pounds, mostly between 15 and 18, the average being 15.9 pounds. These were very uniform, as the superintendent of the shops endeavored to keep them so, though he had no spring balance with which to measure them. The other roads made no attempt at regulation.

The pressure on the cars using the T.-H. bases was very irregular, and varied from 9.3 to 29.1 pounds, a very wide limit. The average was 15.4 pounds. The trolleys jumped and sparked a great deal, and the overhead construction was not especially good. Cars Nos. 3, 5, 6 and 10 were Summer cars, with new bases, and car No. 12 had a new Westinghouse base, which accounts for these pressures being so far above the average. Had the tension of the springs been increased and kept more uniform most of the trouble would have been avoided

The observations were made by Messrs. Charles Reutlinger and B. Harrison Branch, the two students who assisted the author in preparing the article on "Electric Car Tests," which appeared in the *Electric Railway Gazette*, Aug. 31 to Nov. 23, 1895.

TABLE I.

PRESSURE OF TROLLEY AGAINST WIRE.

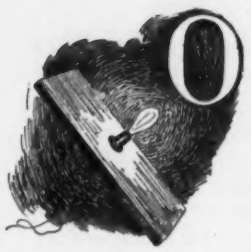
Style of Base.	Car No.	Pressure in lbs.*	Car No.	Pressure in lbs	Car No.	Pressure in lbs.	Num'r of Cars Tested.	Average Pressure.
Westinghouse.	213	19.3	214	24.0	206	23.9	32	**21.6**
	231	20.3	215	33.4	227	23.6		
	221	19.2	216	23.8	209	18 6		
	233	20.7	217	19.0	223	20.8		
	219	20 4	218	19.1	229	28.7		
	210	27.0	201	19.3	211	21.5		
	327	18.4	230	20.4	212	21.7		
	310	16.9	220	17 8	224	20.8		
	226	19.5	202	19.7				
	225	33.2	203	18.7				
	222	19.7	204	23.3				
	228	18.7	205	20.6				
Westinghouse (new equipment).	416	32.8	415	24.5	413	32.4	9	**30.8**
	411	33.4	410	30.3	414	27.3		
	412	31.3	425	31.2	409	33.8		
Baker	238	16.4	113	16.0	247	14.5	30	**15 9**
	291	15.6	242	14 8	237	13.3		
	245	16.8	288	17.9	232	16.0		
	281	14.7	288	18.5	293	16.7		
	282	17.3	246	11.8	235	14.3		
	123	17.8	118	17 7	240	17.0		
	234	15.8	280	15.0	233	15.9		
	236	17.7	241	12.6	239	15.8		
	248	16.8	213	17.7	111	15 2		
	284	21.9	249	16.1	244	11.3		
Thomson-Houston.	63	15.0	51	16.1	59	16.3	30	**15 4**
	74	18.9	8	11.3	39	10.4		
	6	29.1	25	12.9	31	10.4		
	52	17.3	62	14.6	30	9.3		
	71	15.7	5	24.0	34	13.1		
	13	18.1	53	17.1	27	12 2		
	64	14.0	73	14.6	26	9.5		
	56	14.6	14	15.5	3	14.6		
	16	13.5	12	23.7	2	14.2		
	70	15.5	7	13.1	10	18.7		

* Pressure given perpendicular to trolley wire.

Cardinal Satolli at Edison's Laboratory.

A few days ago Cardinal Satolli and a party of ecclesiastics visited the laboratory of Mr. Thomas A. Edison, at West Orange, N. J., where they were received by Mr. and Mrs. Edison. The distinguished party were shown all through the laboratory, and were much interested in all that they saw. Their interest was deepened when some Röntgen-ray experiments were made for their benefit. This enabled Cardinal Satolli and other members of his party to see the bones of their own hands, which results they greatly marveled at. The Cardinal and party next visited the phonograph room, where they were entertained by several selections of a musical and vocal character, and the visit was concluded by a display of vitascopic pictures.

Electric Railways on the Isle of Man.



ON the Isle of Man, which is situated in the Irish Sea, between England and Ireland, is an electric railway system which possesses some unique features in electrical engineering, a description of which no doubt will be of interest to our readers. This, as far as we know, is the first connected account of the railway that has appeared in any American publication.

The Isle of Man is rapidly becoming popular with the English people as a holiday resort and the construction of the electric railway has given a great boom to the island as such. The line enables pleasure seekers to visit the most interesting points of this exceedingly interesting island, and from the facts that follow it will be seen that the undertaking was a wise and profitable one. The island is 30 miles long and 12 miles wide, and is situated 20 miles from the coast of Scotland. Douglas is the main centre of population and is located on the southeast coast of the island, being about 80 or 90 miles in a direct line from Liverpool. The island has an area of 180,000 acres, and is traversed north and south by mountain ranges, the highest peak of which is Mount Snaefell, which rises to an altitude of 2024 feet. The inhabitants of the Isle of Man are of the Celtic race and still speak the Manx language, although English is generally understood.

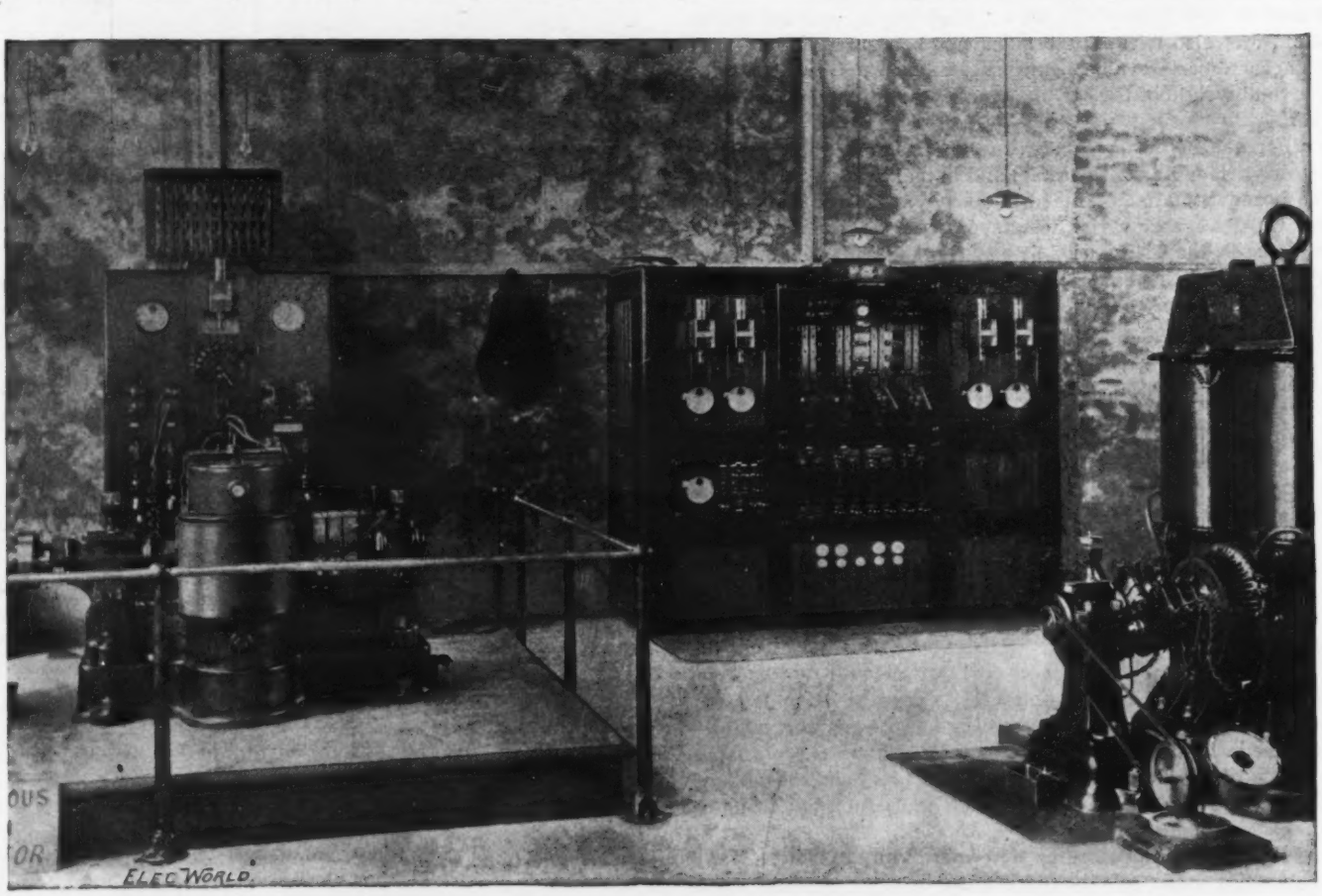
The electric railway is controlled by the Isle of Man Tramways Company and in its construction conditions of exceptional difficulty were met with. That the work was well done, however, may be inferred from the description of its successful operation which follows.

The railway system includes four sections, two of which are operated by electric power, one by horse and the fourth by cable. The southern extremity of the system is at Douglas, and the line is known as the Douglas Bay "tramway." It is operated by horse power and is 1¾ miles in length. This connects with the Douglas & Laxey "tramway" which is operated by electricity and is seven miles long. Then follows the Snaefell electric railway with a length of 4¾ miles, and after that the Upper Douglas tramway, 3¼ miles in length and operated by cable power. This article will be confined to a description of the two electric lines, the horse and cable roads having no particular interest in this connection.

The Douglas & Laxey Electric Railway was opened on July 28, 1894. At the time of the inauguration of the line one car was sufficient to handle the traffic to Laxey, and this ran on 15 minutes headway. New cars have been added from time to time and the road now carries 30,000 passengers per day. The line is equipped on the overhead trolley system, which in construction is very similar to the American practice. The gauge is three feet, but the cars are six feet wide. The line is laid with flat-bottom steel rails of Vignoles section, weighing 50 pounds to the yard, and resting upon sleepers of creosoted wood, supported on a bed of broken stone. For much of the distance the track was cut out of hard slate-rock along the edge of the cliff, requiring the removal of 100,000 tons of rock which were blasted out. Massive cement-retaining walls were built, and in one case the line is laid on a bed of concrete 18 feet deep. For the greater part of the route the road follows the contour of the surface, encountering some long gradients the steepest of which is 1 in 20.

Beyond Groudle station the line is carried across a fine stone bridge of three arches 130 feet long and 50 feet high. It then continues its way and crosses the highway between Douglas and Laxey at an altitude of 337 feet. From Ballebeg station the cars run down Laxey Glen by a moderately steep gradient, varying from 1 in 21 to 1 in 50, this point being six miles from the starting point.

There are two power stations, one located at Derby Castle at the southern extremity of the line, and the other near Laxey. Both stations are supplemented by an accumulator station at Groudle. The Derby Castle station is equipped with three Lancashire boilers working at a pressure of 120 pounds per inch. There are three compound-vertical tandem engines each of 100 indicated horse-power. The governors consist of special adjustable devices on the heavy fly-wheels. Link belting connects the engines with two dynamos of the Manchester type and one of the Mather & Platt type, each having an output of 500 amperes at 500 volts. The switchboard provides means for coupling each of the dynamos to the feeder circuit or the working conductors, and has a Kelvin electrostatic voltmeter for each dynamo. There is also a subsidiary switchboard for connecting independently the rails to the earth plates so that the returning circuit through the earth may be measured. The generators also supply current for incandescent lighting in and about the station, and besides drive a motor-alternator of 30-kw capacity at a potential of 1000 volts which furnishes current for lighting



Power Station at Derby Castle.

public buildings and grounds. Arc lamps have been erected at the top of the poles carrying the conductors for the railway for a short distance between Douglas station and Douglas Bay Hotel.

The Laxey power station is similar to the one above described, excepting that it has two boilers, engines and dynamos.

One of the most interesting features of this system is the accumulator station at Groudle. It is stated to be the first instance of the use of accumulators having a fixed battery for traction work, and is said to have been very successful in regulating the supply of current to the line and reinforcing the power station at times of extraordinary demand. The accumulators have sufficient capacity for operating the line with light traffic. The battery is charged from the line when the full output is not required for the operation of the line, or they may be specially charged. The accumulator plant consists of 240 cells made by the Chloride Electrical Storage Syndicate, London. They have a capacity of 140 amperes for three hours, or of 70 amperes for nine hours at 500 volts. In an emergency 300 amperes or about 200 horse-power can be discharged for 45 minutes without injury to the plates. The battery is connected in parallel with the generating stations and charges or discharges according to the demands of traffic. It can, however, be brought up to full charge at any time by the aid of a booster placed in the station.

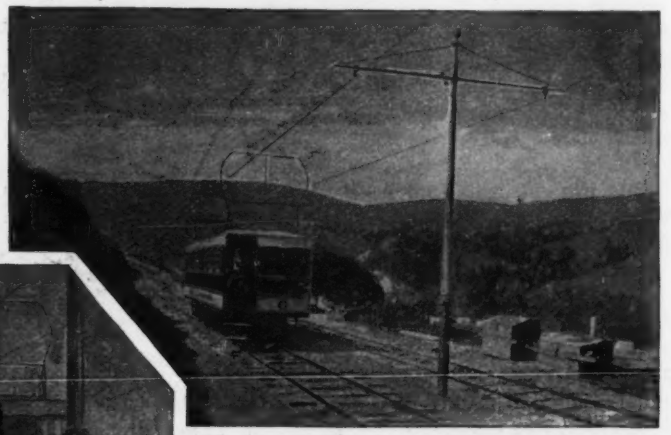
The overhead construction of the line is of the best. The wires are supported on steel poles with double-bracket arms. The conductors consist of No. 0 B. W. G. hard-drawn copper wire suspended from poles at a height of about 16 feet above the rail level. They are fed from an underground lead-covered feeder cable, which extends from the power house at Douglas to the half-way house. Boxes are fixed at suitable points on the line for the purpose of cutting out any section in case of necessity. The rails are utilized as return conductors, and are bonded with copper strips riveted to the under flange of the rail. The current is taken from the conductors by collectors which consist of two bars carried above the roof of the car. This system is the invention of Dr. John Hopkinson, and was used on this line for the first time on an extensive scale. The bars have friction contact along the under surface of the wire, and it is claimed that this contact is much more complete than can be secured by wheel trolley.

The rolling stock consists at the present time of 13 motor cars and 12 trailers, all of which were built in Birkenhead. The motor cars are equipped with two trucks, on each of which is mounted a motor. The motion is communicated to the axle by helical steel single-reduction gear. The motors are designed to give a total tractive force on the periphery of the wheels of 3000 pounds. At each end of the car body are placed regulating and reversing switches, the resistance frames being carried underneath the trucks. The cars complete weigh nine and a half tons, while the open trail cars weigh four tons each and seat 44 passengers—a fully loaded train consisting of motor and trailer cars weighs about 19 tons. They are fitted with powerful hand-brakes and also with Milne's patent continuous automatic emergency brakes which can be operated at either end of the car and come automatically into action if the coupling breaks. The cars are lighted by electric lamps receiving their current from the working conductor.

The line from Douglas to Groudle, which constitutes the section known as the Douglas & Laxey Railway, is approximately seven miles in length and is doubled tracked throughout. The traffic has steadily grown and the undertaking has long since passed beyond the stage of uncertainty. It now yields handsome dividends to the stockholders and is an unquestionable testimony to the economy and efficiency of electric traction in the hands of experienced engineers.

The second electric section of this system, the Snaefell electric railway, is without question the most interesting part of the lines of the Isle of Man Tramway Company. It was opened for traffic in the Summer of 1895, its earlier career having been marked by considerable opposition and doubts as to the expediency of the undertaking. The gauge of the track is 3 feet 6 inches. It is a little broader than the standard in that part of the country, the extra width being thought advisable in order to ensure additional stability for the mountain traffic. Both tracks are laid with three rails spiked with cross sleepers of creosoted timber. The two outer rails weigh 50 pounds to the yard and are fished in the usual manner and electrically bonded with copper strips and double copper rivets. The centre rail is made from the "Fell" pattern and is of rolled steel double headed, weighing 65 pounds to the yard. The centre rail serves as

Laxey Glen, Douglas & Laxey Electric Railway.



Snaefell Mountain Electric Railway.

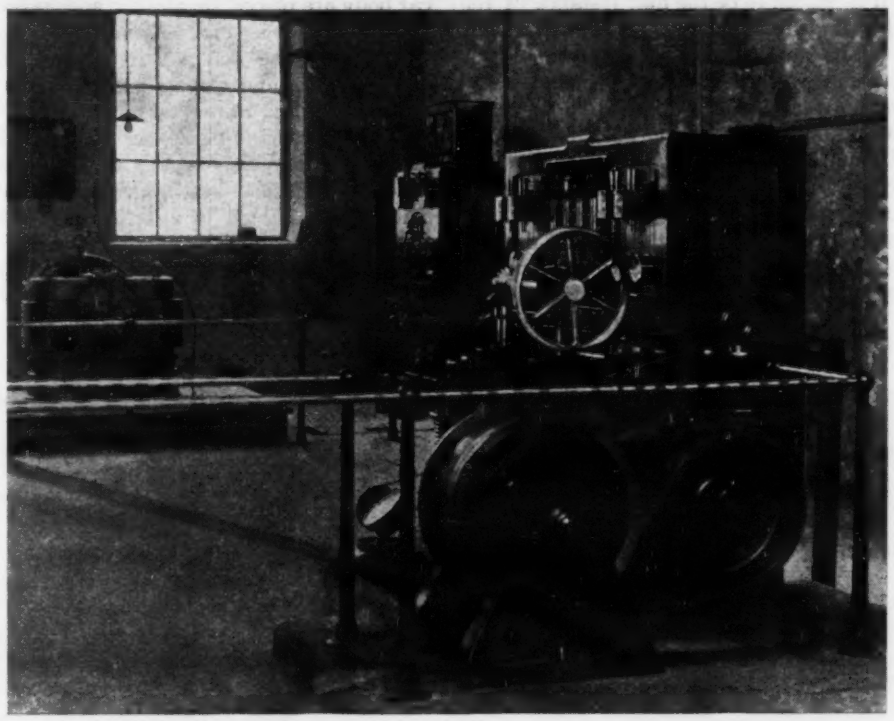
Grade on Snaefell Mountain Electric Railway.

Groudle Station and Inn, Showing Patent Spring Bar Trolley.

Groudle Bridge, Douglas & Laxey Electric Railway.

a guide to prevent the cars from leaving the track, but has no part in the traction which is effected by simple adhesion. The middle rail also provides a surface for the grip of the emergency brake with which every car is equipped in duplicate.

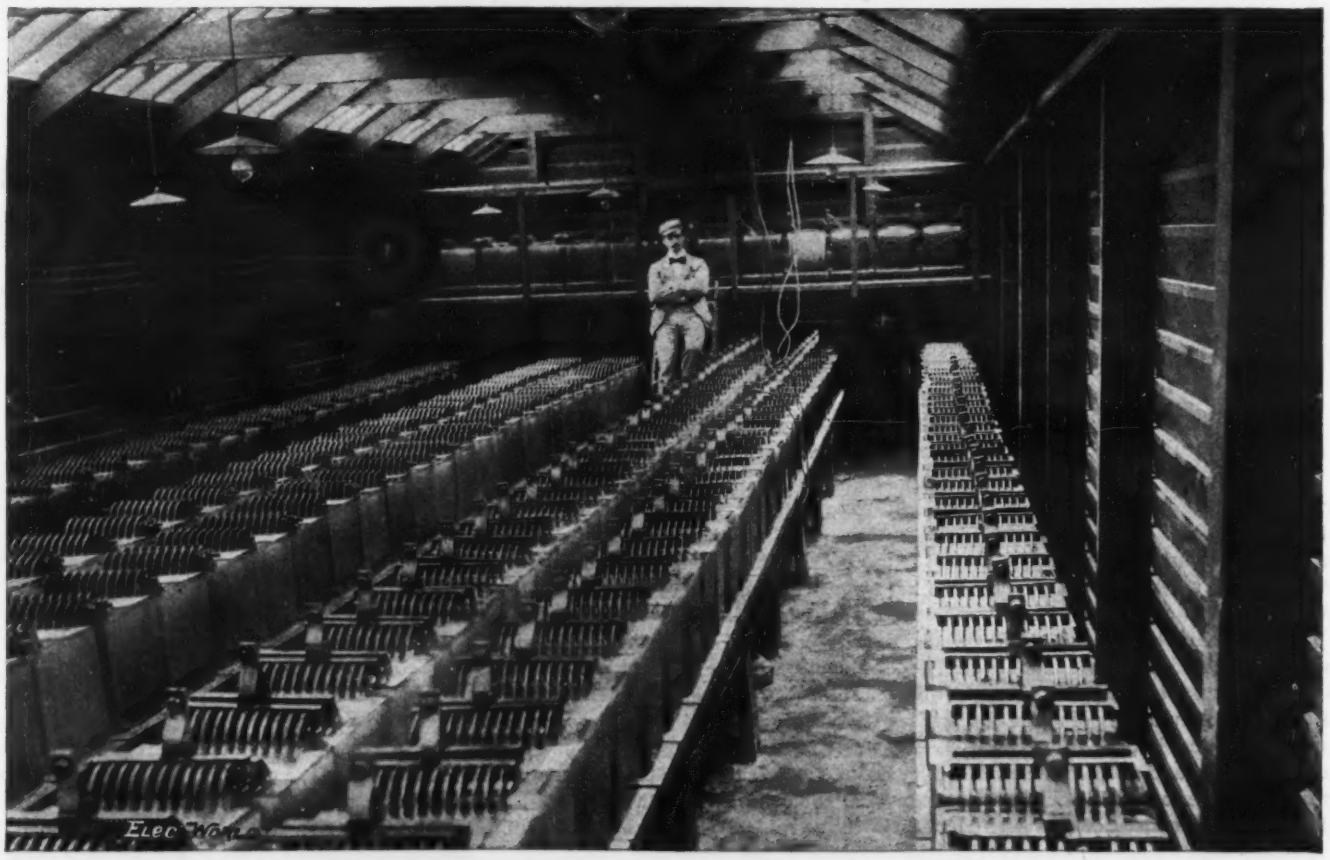
The route of the line is from the town of Laxey to the summit of Mount Snaefell, a distance of 4¼ miles. The line is double tracked and for two thirds of the distance climbs a hilly ridge, the remaining third consisting of the ascent of the mountain peak. The summit is 44 feet below the top of the mountain, or at a height of 1990 feet above the sea level. The lower terminus of the line is 174 feet above sea level, thus giving a perpendicular rise of 1816 feet to the station at the summit, the average gradient being 1 in 12. For the greater part of the distance the track is laid in cuttings on the face of the steep side of the mountain and a very large number of curves, varying from 660 to 1320 feet radius were rendered necessary in the construction of the line. The generating station of this section of the road is located at a distance of 2¼ miles from Laxey, at an altitude of 1400 feet, this site being chosen on account of the plentiful supply of water for the boilers. The station is a stone structure and contains four Lancashire boilers, each giving 160 horse-power at 120 pounds pressure. The engine room contains five horizontal compound steam engines, each coupled by link belts to dynamos of the Manchester type. Both engines and dynamos were made by Messrs. Mather & Platt. Each dynamo runs at 750 revolutions per minute and develops 120 amperes at 550 volts, amounting to a total output of 600 horse-power. The switchboard, which is located in the engine room, is equipped with the usual apparatus, such as voltmeters, ammeters, lightning arresters, switches, etc. Besides these there is also a telephone connection with each end of the line.



Jockey Pulley and Switchboards—Derby Castle Power Station.

As in the case of the Douglas & Laxey line, the Mount Snaefell road is provided with an accumulator plant for the purpose of taking care of any extraordinary loads. The plant consists of 246 chloride storage cells, each specially protected by means of asbestos cloth packing and by a special arrangement with the grid withstands a very high rate of discharge. The capacity of these cells ranges from 176 amperes for three hours to 72 amperes for 12 hours. The methods of charging the batteries are similar to those adopted in the station at Groudle on the Douglas & Laxey line.

The rolling stock of the Snaefell division consists of six motor cars and two trailers. Each is 38 feet long and has a seating capacity of 48 passengers, and is mounted on two trucks of seven-foot wheel base, the diameter of the wheels being 24 inches. Each car is provided with a sand box with a system of pipes for the distribution of sand under each wheel. Emergency brakes are also provided in addition to the ordinary wheel brake. The emergency brakes consist of two steel blocks or shoes, which grip the centre rail. On



Accumulator Plant at Groudle—Douglas & Laxey Electric Railway.

each side of the central rail, on the same level as the emergency brakes, there are two pairs of horizontal idle wheels mounted on spindles. The wheels of each pair of these centre wheels just clear either side of the double-headed guide rail, and their flanges pass underneath this rail. The stout flanges of the guide wheel thus prevent the truck from mounting the traction rail, and make it impossible for the car to leave the track. Each car is provided with four 25-hp Mather & Platt motors, each axle being geared to a motor and every wheel acting as a driving wheel, single-reduction four-to-one gearing being employed. The motors take current at 500 volts, and are connected together two and two in series, thus requiring 120 to 160 amperes per car. Owing to the few stops required the cars are not provided with series-parallel controllers. The starting is made by cutting resistances in circuit, and as the speed is increased gradually cutting them out. The supply of current to the motors is thus left to the discretion of the motorman. A tractive effort of 3000 pounds is required to propel each car at an average speed of nine miles per hour.

As indicating the financial success of the Douglas & Laxey line it is only necessary to state that the dividend for 1895 was at the rate of 8 per cent. after paying debenture interest and 6 per cent. on the preference shares and adding $10,000 to the reserve fund. During that year the number of train-miles run was 104,552, representing receipts of 60.88 cents per train-mile and the expenses were 13.28, giving a percentage of 78.4 per cent. for working expenses. The fares are 25 cents either way between Douglas and Laxey in Summer and 12½ cents in Winter, while the intermediate fares are 6, 12 and 18 cents in the former period and 4 and 8 in the latter. Under these conditions the company secures an average fare of 17 72 cents per passenger. No figures are as yet obtainable touching the operation of the Snaefell section, which was originally constructed by a separate organization, but there is every indication that it will prove a profitable addition to the company's system.

History has repeated itself in the case of this remarkable line in respect to putting new life into communities touched by the road. Douglas and Laxey have both become thriving resorts, and as a result the growth in population and building operations is continually increasing and the reawakening of these old towns in this hitherto out-of-the-way place is indeed remarkable, and is an addition to the long list of evidences of what electricity is doing for mankind.

We are indebted to the *Railway World*, London, for our facts and illustrations.

British Post Office Specification for Glow Lamps.

The following is the specification on incandescent electric lamps as provisorily adopted by the British Post Office and announced by Mr. Preece in his paper on "Electric Glow Lamp Tests," read before the Liverpool meeting of the British Association. An abstract of the paper will be found in the Digest Department of this issue:

Size of Lamp and Terminal.—The glow lamps are to be to the size of a sample which is to be submitted for approval with the tender. In the case of lamps with screw holders the screw terminal is to be strictly in accordance with the standard which will be supplied to the contractor, and to be of such a size that it can be screwed home in the Post Office standard gauge and accurately fitted.

Marking.—Each lamp is to have distinctly marked on the glass the voltage, the candle-power for which it is designed, and the maker's name, with the normal watts per candle-power.

Examination and Rejection of Broken or Defective Lamps.—Each lamp will, on receipt, be tested for continuity of circuit. All lamps having broken filaments, loose terminals, or which are otherwise of defective manufacture, will be rejected, and an equivalent number of good sound lamps must be supplied free of charge by the contractors.

Lamps to Be Selected for Test.—From the bulk of each delivery a number of lamps will be selected at random and tested electrically and photometrically. This number will vary according to the quantity delivered, *viz.*, 3 per cent. of a delivery of 1000 lamps or under; 2 per cent. of a delivery of 1000 lamps and up to 3000, and 1 per cent. of a delivery of over 3000 lamps, will be tested. The Postmaster-General reserves the right to reject the whole delivery if more than 25 per cent. of the total number so selected fail to pass either or all the tests hereafter specified. If further tests are undertaken at the contractor's request, it will be at his own risk and cost.

Tests.—The following tests will be applied to all the selected lamps:

1. A photometric test to determine the actual candle-power of the new lamp at its standard pressure, and an efficiency test to determine the watts per candle. The limits of candle-power, and the maximum watts per candle-power allowable for each kind of lamp tendered are set out in the attached table.

2. After being so tested, the pressure at the lamp terminal will be gradually raised until it reaches in 2½ minutes the pressure stated in column 5 of the table. This pressure reached, the current will be at once turned off

3. The lamp will then be retested as described in Test No. 1, The limits allowable for each kind of lamp as regards candle-power, and the maximum watts per candle-power, are set forth in the attached table:

Terminals.	Standard C. P.	Standrd volts.	Test No. 1. C. P. Max.	Test No. 1. C. P. Min.	Test No. 1. Mx. wts. per cdle.	Test No. 2. Pressure raised to in 2½ min. Volts.	Test No. 3. C. P. Max.	Test No. 3. C. P. Min.	Test No. 3. Mx. wts. per cdle.	Test No. 4 Pressure raised to in 3 min. Volts.
E. S. or B. C.	8	100 or 105	8.5	7.5	3.9	170.2	8.8	7.2	4.1	210
	8	110 or 115	8.5	7.5	3.9	174.6	8.8	7.2	4 1	215
	16	100 or 105	17	15	3.75	170.2	17.6	14.4	4.0	210
	16	110 or 115	17	15	3.75	174.6	17.6	14.4	4.0	215
	25	100 or 105	26.5	23.5	3.5	170.2	27.5	22.5	3.75	210
	25	110 or 115	26.5	23.5	3.5	174.6	27.5	22.5	3 75	215
	32	100 or 105	34	30	3 4	170.2	35	29	3.65	210
Lug...	50	100	53	47	3 3	.....	..	..	..	...
	100	105	106	94	2 9	.....	..	..	..	...

4. In lieu of Tests 2 and 3 a proportion of the lamps not exceeding one third of the whole number selected for test will be raised gradually in three minutes to the pressure stated in column 7 of the table. The lamp under test must not fail in any way while the pressure is being increased from its normal voltage to that named in column 7 of the table.

5. The candle-power of all lamps tendered for must be in terms of the English standard candle.

NOTE.—The Post Office measurements will be made with an improved Trotter photometer and the standard of light will be either the Vernon-Harcourt or the Hefner amyl-acetate, the former being taken for the purposes of this specification as one English candle, and the latter as 0.88 of an English candle.

Relative Cost of Copper with Various Systems.

In a paper read before the Institution of Electrical Engineers, on "Some Distinctive Features of Continental Electrical Engineering Practice," Messrs. Edgecumbe and Fox give the following table setting forth the economy of copper in electrical transmission by the various systems. Two distinct cases arise, (1) where the maximum potential difference is fixed, and (2) where the effective voltage alone enters into the question :

SYSTEM.	WEIGHT OF COPPER. Case 1.	WEIGHT OF COPPER. Case 2.	COST OF CABLE. Case 1.
Direct Current	100	100.0	100
Single-phase, 2 wires	200	100.0	146
Two-phase, 4 wires	200	100.0	200
Two-phase, 3 wires	291	72.8	218
Three-phase, 3 wires	150	75.0	150
* Three-phase, 4 wires	....	29.2	....

* In case of a three-phase four-wire system the wire from the neutral point is supposed to have half cross sectional area of the other three wires.

Why Certain Insects Have Lensless Eyes.

At the recent B. A. meeting Prof. S. P. Thompson suggested that X-rays may be the ordinary means of optical communication among fire flies, and that, for that reason, Providence had not found it necessary to furnish the insect's eye with a lens.

Detecting the Quality of Porcelain by Means of X-Rays.

Prof. Rucker recently showed that Röntgen rays may be used to distinguish between various qualities of porcelain, those containing phosphatic china being more opaque than those in which it is not contained.

New Repair Shop of the Brooklyn Heights Railway Company.

WHEN the Brooklyn City Railway was leased to the Brooklyn Heights Railway Company the latter came into possession of the land adjacent to the southern power-station on Fifty-second Street. There was on this property at the time a car barn, an old power-house and the feeder tower of the power-house, located near the water front. The car barn was used as a repair shop, which increased in size from a small corner of the barn which it formerly occupied to the entire building, which was by no means small. The needs of the combined interests so largely increased the work of this department that a new repair shop has been constructed and is now almost ready for occupancy. It will probably not be outgrown for a long time to come. The plans of the architect are shown in the accompanying Figs. 7, 8 and 9, so that those familiar with the locality will at once see that the structure extends from the old car barn to Second Avenue, where the old power-house, since removed, stood. The wire tower still forms part of the new building. The main feeders pass through porcelain bushings set in the outer wall in the manner shown in the initial letter. The wire tower may be seen sketched in dotted lines on the architect's plan, which gives also the foundations of the old power-house.

The building is of brick with wooden pillars and roof trusses, and has a frontage of 100 feet on Second Avenue and 350 feet on Fifty-second Street. It is two stories high and is divided into two parts by a long wall parallel to Fifty-second Street. The smaller of these two parts is nearly 40 feet wide and is divided into a long workroom, a stockroom and offices for the foremen of the repair shop.

Fig. 6.—Interior View Repair Shop

The floor of the shop is of grouted stone and cement-covered with a layer of almost clear cement. It is blocked off into flags and has the appearance of being paved with Medina sandstone. Three double doors in front admit the cars and ample tracks are provided on both floors of the building together with transfer tables.

The rails are of the flat box type and are admirably suited for

Fig 1.—Forge Shop.
Fig. 2.—Winding Department.
Fig. 3.—Insulating Department.
Fig. 4.—Various Types of Armatures.
Fig. 5.—Machine Shop Department.

such purposes. They may be easily secured to the floor without prominently projecting above the same. This type is also durable and cheap.

The entire building is steam-heated from the southern power-station, while 500-volt stationary motors supplied from the same operate the necessary machinery. Fig. 6 is a view of the interior of the new shop, giving an idea of its present condition. Long benches will be placed along either side under which will be placed steam radiators.

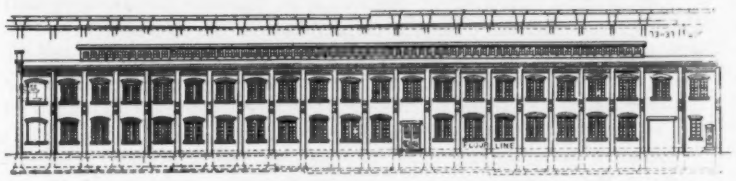


FIG. 7.—SIDE ELEVATION—REPAIR SHOPS BROOKLYN HEIGHTS RAILWAY COMPANY.

An electric car elevator used for lifting cars, from the first to the second story is a feature of the shop. It has a capacity of 40,000 pounds and is driven by a 20-hp Perret motor, direct-connected to a worm which through a train of gears turns a shaft carrying four winding drums. These drums each have two ropes running to the elevator platform. The platform is balanced by eight counterweights, each supported by one of the ropes. The platform is guided by T-

FIG. 8.—FRONT ELEVATION—REPAIR SHOPS BROOKLYN HEIGHTS RAILWAY COMPANY.

irons, as are also the counterweights. There are four such guides for the elevator, one at each corner. The platform is 40 feet 2 inches by 10 feet 8 inches and its location may be seen from an inspection of the architect's plans. The multipolar motor is provided with a brake and resistance control.

The building has an entrance for cars at its extreme end on Fifty-second Street, shown in the plans. The old repair shop is more or less interesting partly as a criterion of the facilities which will be placed in the new shop and partly because it affords an idea of the large amount of work done there and the necessity for enlargement. Fig. 2 is a general view of the winding department, and in Fig. 4 is shown a group of armatures. From these it will be seen that the road has in service almost every kind of motor from the old S. R. G. to the most modern General Electric, Westinghouse and Walker types.

Fig. 3 is a view of the insulating department. All the coils are formed here and in many cases they are a great improvement on the factory practice. This department also is now a very busy one.

Fig. 5 is a view of the machine shop, which it will be noted is well equipped with lathes, planers, shapers and similar appliances for the rapid and ready repair of street railway apparatus. Fig. 1 is a view of the forge shop, which is well provided with tools for the work which is carried on there.

The Brooklyn Heights Railway Company has added to its rolling stock a large number of new cars, trucks and motors and the old part of the repair shop is very busy preparing these for service. Everything concerning these new equipments is of the most modern type.

This shop will give employment to about 300 men and will consolidate all the equipment and car repair work, which will result in much greater economy.

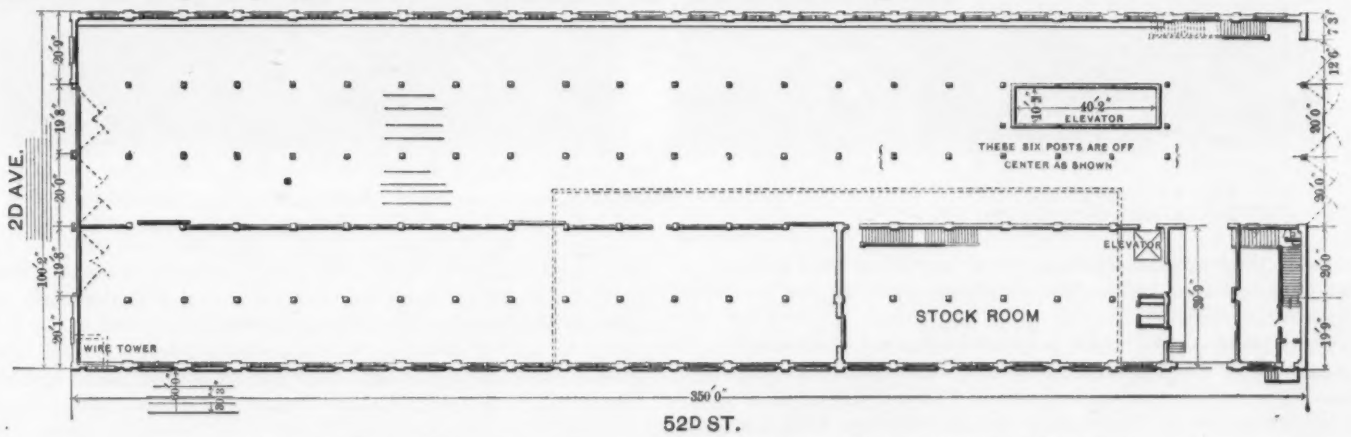


FIG. 9.—FIRST STORY PLAN—REPAIR SHOPS BROOKLYN HEIGHTS RAILWAY COMPANY.

The Niagara-Buffalo Power Line.

The construction of the line which is to carry the electrical power current from Niagara Falls to Buffalo is progressing rapidly. Pole line is used along the route to the distributing station at the foot of Brace Street, in Buffalo. At this point the conductors go underground to the power-house of the Buffalo Railway Company.

The conduit from the Brace Street station to the power-house is completed.

There are 12 three-inch tiles in this conduit, laid in three tiers of four in a tier. The tiles are laid on a bed of broken stone and concrete six inches deep and each tile is completely insulated from the other and surrounded by the same substance, making it absolutely impervious to water. From the terminal station to the power-house is exactly a mile, and 20 manholes have been placed between the two points. From one manhole to another the distance varies from 200 to 300 feet, and the tile line between any two manholes is perfectly straight. When the course of the conduit diverged in the slightest degree, a new manhole was sunk and another straightaway course followed. Twelve cables is the maximum capacity of the present line, although only three cables are being strung for immediate use. These will convey 10,000 horse-power, the combined energy of two of the great power turbines at the Falls. The power will be distributed from the terminal station, from which point begin all the branch lines to mills and factories. Some of the lines will be laid underground, but more will be carried on poles. For a time only two cables will be laid to the Buffalo Railway Company's power-house, as the first contract calls for only 1000 horse-power, 9000 more horse-power having been contracted for providing the scheme of transmission proves to be successful. Transmission will be by copper conductors of stranded wires, three quarters of an inch in thickness, three strands to the cable. The perfect insulation of these conductors is secured by a very thick layer of rubber and an outer covering of lead, making a cable altogether of nearly two inches in diameter. It is stated that these cables will carry the greatest amount of electric energy that has yet been successfully transmitted undergrond.

The exact length of the line from the power-house in Niagara Falls to the power-house of the Buffalo Railway Company is 26 miles, 18 of which is over the private right of way. The balance is along the towpath of the Erie Canal, on Government property. Seventy-eight miles of copper cable weighing 245 tons are necessary to complete the three lines and over 2000 poles are required to support this enormous load.

Some Prominent Features in Electric Railway Construction.

THE vicinity of New York is replete with electric roads, the construction of which has involved a great deal of engineering skill. The problems which have been successfully overcome and the methods employed in their solutions are worthy of a more complete description than has been accorded them in the articles that have been published on the respective plants in which they are to be found. They are not only interesting, but will be valuable as a reference.

Several notable instances of engineering difficulties in railway work are to be found in the lines of the North Hudson County Railway Company. Among them the Hillside line includes a section of track commencing at about Fifteenth Street, Hoboken, N. J., and ascending to the top of the Palisades, a total distance of 156 feet above tidewater. It is not probable that this section of track is duplicated anywhere in this country. It begins on a long trestle at the foot of Fifteenth Street, which in its entirety is about 1500 feet long. This trestle runs to the south, and sweeping a complete half revolution on a 55-foot radius, turns northward again. A view of it is presented in Fig. 5, and, as will be noted, is taken from a point higher up the cliff. The track continues northward for about 1800 feet, and then swings another curve known as the "Horseshoe," which has a 50-foot radius, and finally proceeds to the top of the hill.

The horseshoe curve, which is shown in Fig. 3, is built mostly upon filling on the side of the hill, the same being backed by a solid wall of masonry exceeding 100 feet in height. There is no section of this track over 50 feet in length that does not deviate from a straight line. The total length of the whole construction is 3600 feet. The least grade is 1½ per cent. and the steepest 5¼. Wherever the road runs over soil it is stone ballasted. A 56-pound T-rail rolled by the Pennsylvania Steel Company is used on the track. It is 4¼ inches high and bolted to its inner side is a guard rail with a flange so broad that it is almost impossible for a car to become derailed. The track is bonded with double Chicago rail bonds. The cars used on this section are 16, 18, 22 and 24 feet in length. The 16 and 18 foot cars are equipped with W. P. 50's or G. E. 800's. The 22-foot cars are equipped with two G. E. 1200 motors, as are also the 24-foot cars, but some of the latter have four G. E. 800 motors and a four motor controller. These cars are allowed under ordinary circumstances to run up the grade with the motors in series, but under heavy loads they are switched in parallel. Five minutes is allowed for descending, which gives a total of nine minutes from the top of the grade to the ferry. The speed when ascending is over 10 miles an hour. The total cost of this construction is estimated at $100,000.

The elevated construction beginning at Barclay Street ferry and extending to the car house, a total distance of two and one half miles, is also an interesting piece of engineering work. From the ferry to the top of the hill, an elevation of 96 feet, is one and one quarter miles. The maximum grade is 5 per cent. The length of the incline is 2100 feet, and the greatest height above the ground is 75 feet. Fig. 4 shows the approach to the elevated construction at the bottom of the hill. The rail is a 68-pound T-rail, and is provided with guard rails in a similar way to that employed on the Hillside line at Fifteenth Street. The cars are allowed two and one half minutes to descend this grade. The construction contract was carried out by the Passaic Rolling Mills Company, and up to June, 1892, the cable was employed as a means of traction. The electric system was tried at that time, and proved so successful that the cable equipment was entirely done away with.

Another piece of engineering is the elevator at Weehawken, the cost of which was $500,000. When it was completed in April, 1892, it was expected that an immense traffic would result and that Weehawken Heights would be rapidly built up. For some reason the locality did not prove as popular as expected and the traffic did not warrant the maintenance of this enormous construction, so in July, 1895, it was abandoned. Its commercial failure, however, has in no way compromised the engineering ability that executed it. It has a height of 165 feet and the total length is 1600 feet. There are three powerful elevators, each capable of lifting 100 passengers. A view of the elevator is shown in Fig. 1. The top of the bluff is now reached by a very steep section of track, which ascends the hill diagonally. A view of this grade, photographed from the top of the elevator, is shown in Fig. 2. The steepest grade is 7 per cent., and the length is 2800 feet. The sharpest curve has a radius of 75 feet. The rail is a 56-pound T and is provided with guard-rails similar to those used on the grades just described. The 24 foot cars run regularly on this grade and easily make over 10 miles an hour. The ultimate elevation is 165 feet above the West Shore tracks.

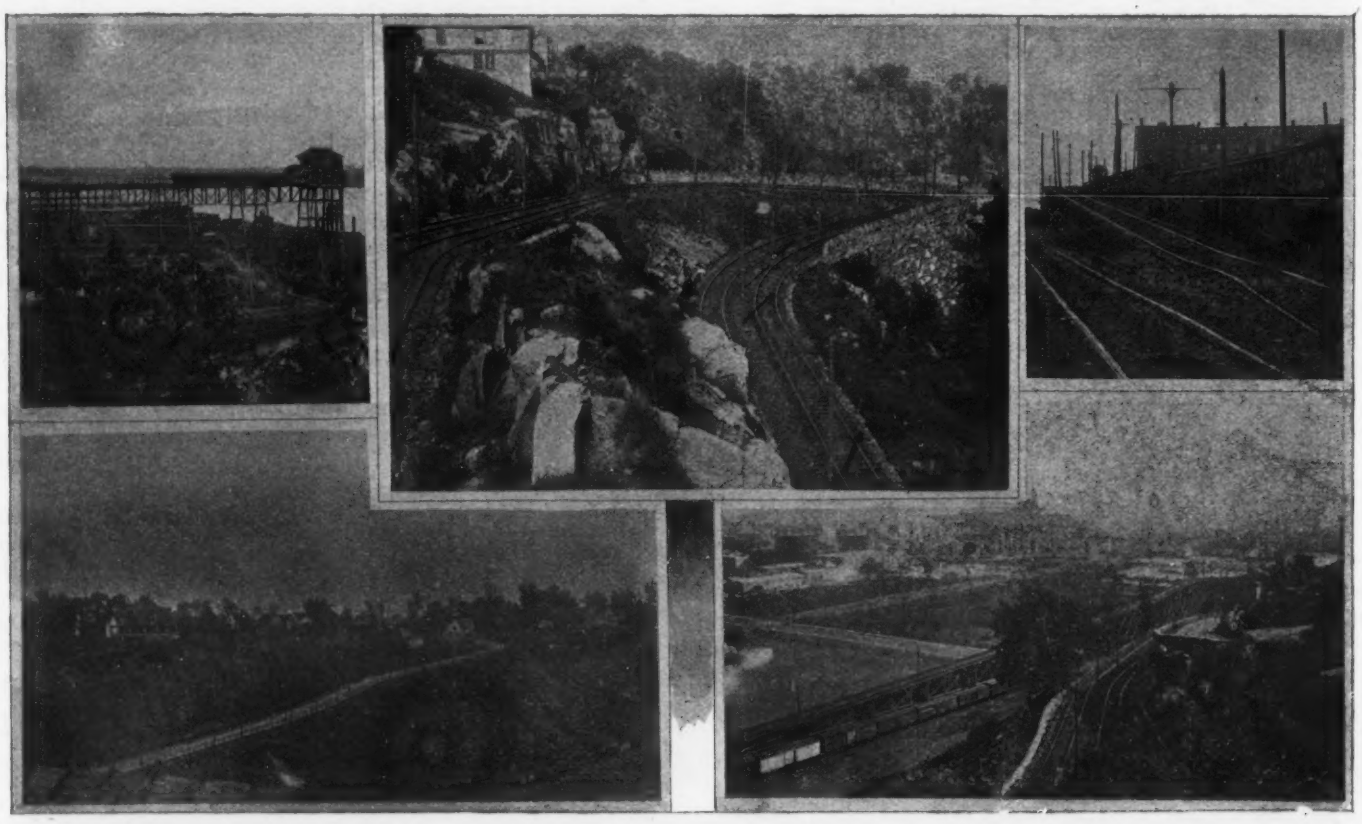


FIG. 1.—ELEVATORS.
FIG. 2.—HILLSIDE GRADE.
FIG. 3.—"HORSESHOE."
FIG. 4.—VIADUCT AND APPROACH.
FIG. 5.—TRESTLE AND INCLINE.

Two and one half minutes is the running time in descending the grade.

The little South Orange & Maplewood electric railway, although it is only a few miles in length, contains several engineering features of interest. Under Montrose Avenue is a concrete tunnel which has been built at a cost of about $16,000. It is said to be one of the largest pieces of concrete work in the country. The necessity for such a thorough construction arose from the fact that when making excavations they discovered a spring which supplied a continuous stream of water equivalent to the discharge of a two and one half inch pipe, and it was decided that the concrete supplemented by the best Portland cement construction was the only thing that could effectually shut it out. Thus far, however, this method has not proved adequate, as water continues to percolate through the cement walls, so that an auxiliary track, shown in Fig. 6 at the left of the picture, has been laid, crossing Montrose Avenue, which is at present being temporarily utilized. The north approach to the tunnel has a grade of 8½ per cent. and at the end is a spiral curve of 60 feet radius. This curve is shown in Fig. 7. The south approach is 150 feet long and has a 6 per cent. grade. The abutments are three feet in thickness and are laid with the best quality of Portland cement. The ballasting of the approaches is done with 12 inches of concrete, and the retaining walls, also of concrete, extend to the level of the ground. A single track goes through the tunnel with diamond turn-outs at either end and an automatic signal system is provided to tell whether or not the tunnel is clear. It is being attempted at present, with but partial success, to keep the tunnel clear from water by a Hall centrifugal pump of a capacity of 1200 gallons per hour, which is directly coupled to an electric motor operated on the trolley current. It is believed that the walls will soon become sufficiently saturated to prevent further percolation.

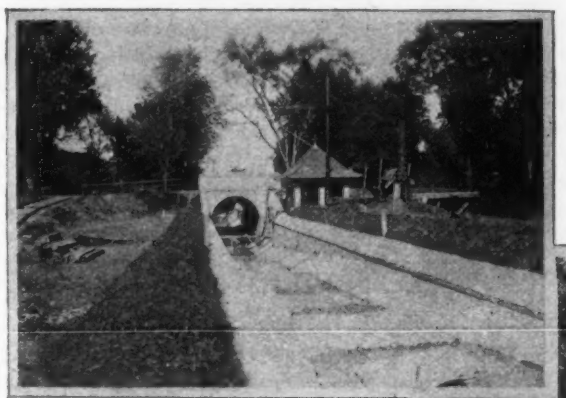


FIG. 6.—TUNNEL.

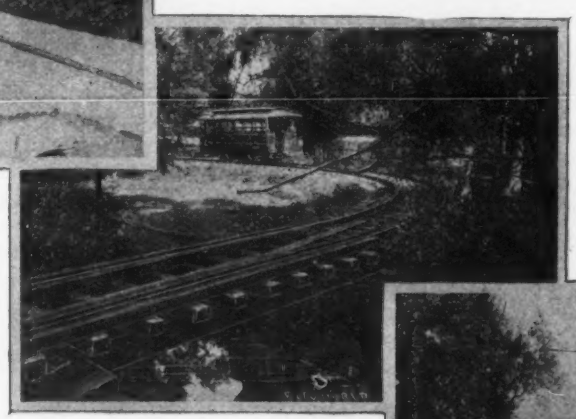


FIG. 7.—SPIRAL CURVE.

Another sharp curve on this road is shown in Fig. 8. The rails are all of the T type.

From the foregoing it seems reasonable to draw the conclusion that ordinary car equipments such as are supplied by the large companies are sufficient to cope with almost any grades that may be encountered in practice. At the notable grade in Ithaca, 11.6 per cent., W. P. 50 equipments are operated with perfect satisfaction. It therefore seems idle to go into elaborate engineering calculations regarding the ability of electric equipments to mount any grades which a car can climb by the rotative effort of its own wheels. Even on steeper grades it is incorrect to state that the cable is the only feasible method, for the performance of the electric system of traction leaves no room to doubt that with an efficient rack rail system, electric traction could complete in this field also.

Electrical Engineering During the Queen's Reign.

The City of Newcastle, England, proposes to celebrate the sixtieth year of Queen Victoria's reign by holding an exhibition the main object of which will be to demonstrate the progress made in electrical engineering between the years 1837 and 1897.

A New Method of Detecting Waste of Power in Electric Railways.

BY HAROLD P. BROWN.

Our mechanical engineers during the past few years have so perfected the steam plant in the railway power-houses that there seems little margin for further improvement. The motor and dynamo designers have pushed their art to its utmost economical limits, while the electrician claims to have used ample section of copper in trolley feeder wires. And yet the amount of power delivered by the dynamos is out of all proportion to the power actually utilized at the car axles. There is a large loss somewhere, and the object of this paper is to give railway electricians a new and simple method of proving its existence and of definitely locating it; the correction of the evil is a later consideration. Many managers claim high efficiency for their power plants, and the ordinary forms of station records seems to justify their faith. But Mr. Thomas Henning has recently called attention to the injustice of using "car miles" as a basis for comparison between different power-houses, since the weight and speed of cars, the grades, the distances and the line losses are not considered.

The only fair basis for such comparison is the coal consumption per kilowatt delivered by the dynamos. The relation between the number of watts generated and the number of watts used by the motors should, of course, give the electrical efficiency of a railway. This efficiency can be approximately determined by taking hourly records of watts generated and dividing by the number of cars in actual service during each corresponding hour, thus obtaining the watts developed per car. From averages of wattmeter records the power required by a standard car on each line at time of light and heavy loads can be determined and the average efficiency obtained. Or, knowing average weight of cars, average speed and efficiency of motors, the watts per car can be closely calculated. In this manner the power efficiency of several leading roads has been found by the writer to be less than 45 per cent at heavy load. Each of these roads has a finely equipped power plant, multipolar dynamos, modern types of motors, with series-parallel control, excellent tracks and apparently ample feeders.

FIG. 8.—APPROVED TYPE OF TRACK CONSTRUCTION.

The management of each company had willingly spent thousands of dollars to obtain economical production and distribution of power and felt proud of their equipment. Convinced that the trouble was caused by poor rail returns, the problem was to prove it, first to myself and then to them. On one road a double track of 90-pound girder rail passed the front of the power-house and led to the meeting point of 10 or 12 similar lines, having a total consumption of about 8000 amperes.

These rails have been in service about 18 months and each joint had two Chicago bonds 8 inches long and 0.43 inch in diameter.

The bonds had been carefully applied by a competent mechanic. Examination showed that they were perfectly tight and in apparently good condition. Tests made with a Weston instrument reading to 0.01 of a volt showed very slight deflection at these joints. The drop was small with 100 or even 500 feet of the rail. And yet at time of

heavy load the pressure between trolley wire and rail was very low.

In a conduit below these rails was a feeder of 1,000,000-cm section, with taps to the rail at every manhole. The pressure rose at the taps but quickly dropped in a few rail-lengths. Readings were made at heavy load throughout each line and the pressure found everywhere low, though the trolley feeders were generally of ample section and the drop at rail joints small. An insulated rail feeder of 1,000,000 cm was connected to a line from which 700 amperes should return. At the point of contact the pressure was normal but dropped within a few hundred feet, and only 60 to 75 amperes returned by the feeder, while the current on the gas and water pipes was enormous.

It was impossible to account for the existing conditions except upon the theory that the rails were not doing their proper duty and the pipes were consequently overloaded. To determine this the writer ordered from the Weston Company a special milli-voltmeter reading to 0.0001 of a volt. When this instrument was received a piece of the 90-pound rail was taken to the power house and put into circuit with a rail feeder and an ammeter. The drop of voltage in one foot of the rail and the current through same were noted. The rail resistance was found to be 0.00001 ohm per foot and a constant was obtained by means of which the current through any similar rail in service could be determined on the street by noting with the same instrument the drop in one foot. Measurements were then made upon the line passing the power house and each rail was found to be carrying but 25 amperes instead of the 700 to 1000 which would be its proper load.

A similar low-reading instrument was connected at the rail joints, and the drop was then shown to be entirely too large for the very small current transmitted. In making our previous measurements of drop only, when we assumed a heavy current flow, the low reading gave the bond a certificate of great efficiency, but when the current was simultaneously measured and found to be insignificant, the high resistance of the bonds was no longer concealed. Quite a number of the bonds were removed for examination. All were found to be mechanically tight, but the contact surfaces of the copper and of the steel proved to be entirely covered with a black greasy deposit.

This was the secret of the great waste of motive power, the cause of the heavy load upon the pipes and the origin of electrolytic corrosion of cable armor and of gas and water mains which had given so much trouble. As some of these pipes carry natural gas at high pressure, I am waiting with great anxiety for the remedy to be applied.

A leak in a wrought iron natural gas pipe is so easily started by electrolysis, it is so hard to detect and locate, and so apt to cause frightful explosions, that a load of 300 to 400 amperes on an eight-inch pipe is not a pleasant thing to contemplate. This same milli-voltmeter will, of course, indicate from the drop in one foot of pipe of known weight the exact number of amperes carried. Only a few weeks ago in opening a natural gas pipe in the same city, the spark between the parting ends ignited the gas, and one of the men was badly burned. Fortunately the gas pressure had been turned off or he would have been cremated.

In work of this kind a heavy copper cable should be clamped upon bright contact spots on each side of the joint before the pipe is opened. The delicate Weston instrument by the very simple test above described proved that fully half of the loss of power had been caused by a film of oxide on the contact surfaces of the bonds; it showed that the best copper bonds lost their efficiency in less than two years; it demonstrated that in this particular plant a large portion of the investment in engines, boilers and dynamos could have been saved had the rails been available as conductors in their entire section. This result electric rail-welding attempted to secure, but aside from the now well-known mechanical effects of the process, the presence of the flux between the welded surfaces caused a high resistance which the milli-voltmeter detects. I have not yet made sufficient numbers of measurements of these joints to publish results.

But I have already tested several hundred cast-weld joints which have been in service about 18 months. These joints are also bonded with copper wire, but the drop of one foot of rail including the joint averages from three to ten times that of a foot of rails between joints.

The current carried by the rails is also small and there are occasional joints with as much as one volt drop.

I have seen a report of test of a sample cast-weld joint which had never been under ground nor in service, in which was used a voltmeter reading 0.01 per degree, while the observed drop was expressed in decimals to the fourth place! Also another test with same instrument, in which the drop of about 2000 feet of double track was measured with less than 120 amperes current, from which it was apparently assumed that the current flowed upon two rails only, and that none was carried by crossbonds, by the earth or by pipes underneath. Here again the result is expressed in decimals beyond the reach of the instrument!

I have personally gone over miles of track having this joint, taking readings to 0.0001 of a volt, measuring drop of one foot of rail including joint, and of one foot of same rail away from joint, and I am forced to conclude that the character of the iron, of the climate or of the instruments used account for the widely differing results. My tests show that while this joint is mechanically most excellent, it is not a permanent bond and does not show a low resistance on at least one road. An electrically continuous rail is certainly very desirable. The metal is required for mechanical purposes; the electrical use of its entire section would give to its owners the service rendered by 1,000,000-cm of copper weiging 16,000 pounds per mile for each line of 90-pound rail.

Its conductor value in terms of copper equivalent would exceed $1900 per mile for each rail. It would largely reduce the transmission losses and thus diminish the necessary power investment, or it would correspondingly decrease the amount of copper required as trolley feeders at a given percentage of loss.

With this in view, is it wise for engineers and managers to be content to have their magnificent conductors left in lengths of 30 to 60 feet, electrically joined by mere strips of copper whose contacts are entirely inadequate even when new, and whose low efficiency is rapidly decreased in service? Is it not worth their while to at least get a pair of these low-reading Weston instruments and definitely determine how much current is carried by their rails, how much energy is lost at the joints and how much injury is inflicted upon the underground pipes?

Electricity in Surgery.

In a paper by Dr. W. J. Herdman, on "The Application of Electricity to Surgery." read before the recent meeting of the American Electro-Therapeutic Association, the author gave a very clear explanation of the action of a direct current on living tissue. When passed through such tissue, he states, it causes at the point of contact of the positive electrode or anode, provided the current is of suitable strength, an accumulation of oxygen, chlorine and the acids. These, by combining with the albumen in the adjacent tissues, cause coagulation, drying and shrinking of the tissue in immediate contact with the electrode. This effect can be brought about in any structure, therefore, when such an action is likely to prove helpful. About the negative terminal or cathode, on the contrary, the alkalies and hydrogen accumulate, and these have the effect of softening and liquefying the tissue adjacent to the electrode, and there are many abnormal conditions met with requiring surgical interference for relief where this action would meet the indications.

Any abnormal growth may be arrested or removed by robbing it of its blood supply, and we have in this process a simple and efficient means for bringing this about. Such growths, when treated in this manner, gradually shrink up and are absorbed, leaving, in most instances, no evidence of their former presence.

The softening and liquefying effect of cathodal electrolysis is especially serviceable in the removal of non-vascular, dense, horny or warty growths or bony or cartilaginous tissue. Cicatricial tissue, resulting from burns, wounds or inflammations, is of this dense, non-vascular kind, and is oftentimes Nature's best effort at repair.

Partial Programme of the Convention.

A complete programme of the American Street Railway Association meeting has not yet been given out; the subjects of some of the papers to be presented before the convention have, however, been announced. They are as follows:

Track and Track Joints, Construction, Maintenance and Bonding.

Trucks.

How Can the Revenues of Street Railways Be Increased, Taking Into Consideration the Collection of Fares, Method of Registry, Transfers, Use of Tickets or Cash Fare, and Attractions Along the Line of Road?

Modern Overhead Electric Construction.

The Modern Power House.

Selection and Management of Employees. (To be discussed at an executive session.)

DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

BY CARL HERING

COMPILED FROM THE PRINCIPAL FOREIGN AND AMERICAN JOURNALS.

DYNAMOS, MOTORS AND TRANSFORMERS.

Graphical Treatment of Alternating-Current Problems. HEYLAND. *Elek. Zeit.*, Oct. 1.—The first part of a reprint of a recent paper describing simple or graphical methods for treating alternating-current problems. The method is based on the fundamental principle that the current in any alternating-current circuit is given directly by the number and phase of the lines of force linked with the circuit. In the transformer this is very simple, as with a constant voltage the field for varying loads is constant and is given directly by the sum or difference of the ampere windings in the primary and secondary circuits; that is, by the magnetization current; the currents in a transformer can therefore be represented by a right-angled triangle, one of whose sides is a constant and represents this current, while the second side represents the secondary current and the hypothenuse the primary current, in ampere windings. In the alternator the field of the armature is based on the sum of the magnetizing actions of the exciting current and the armature current; this is the same for the synchronous motor; for the multiphase motor the field of the armature is given by the approximately constant field of the excitation, from which is substracted the leakage field between the exciting and the short-circuited coils; a single-phase motor is treated like a multiphase motor. In the present portion he discusses alternators at different loads, their connection in parallel, transmission of power between two alternators, and the effect of the ohmic loss in the line.

Dynamos at the Berlin Exhibition. MITTELMANN. *Elek. Zeit.*, Oct. 1.—A continuation of some length, of the description of the exhibits at the Berlin exhibition (see *Digest*, last week); in the present portion the Lahmeyer dynamos are described with the aid of a large number of illustrations.

Dynamos. BOISTEL. *L'Eclairage Elec.*, Oct. 3.—Some illustrated descriptions of recent improvements, chiefly in the winding of armatures, which appear to be mostly of American origin.

Elementary Study of the Operation of a Transformer. ALIAMET. *L'Elec.*, Oct. 3.—The beginning of a series of articles.

LIGHTS AND LIGHTING.

Incandescent Lamp Tests. PREECE. Lond. *Elec. Rev.*, Oct. 2; the conclusion of his B. A. paper (see *Digest*, last week); the reprint is continued in the Lond. *Elec. Eng.*, and a long abstract of the complete paper, with some of the curves, is published in the Lond. *Elec.*, Oct. 2.—It includes a table giving particulars for the average breaking voltage for some of the lamps, other tables giving results of experiments with three fourths of the breaking voltage. Among other things he states that the candle-power in some cases was found to be more after the filaments have been raised to a high temperature and re-tested at the initial pressure. He summarizes the results of these tests as follows: "The continuous lighting experiments show that the candle-power falls about 30 per cent. in 1000 hours, and the watts per candle rise about 28 per cent. in the same time, as illustrated in the curves, which connect time with candle-power (percentage) and watts per candle. In installation work lamps of about three and three fourths watts per candle, burning from seven to nine hours a day, behave as regards life and efficiency about the same as when giving continuous illumination, but high-efficiency lamps deteriorate more quickly. That good 100 or 105 volt 16-cp lamps, taking three and three fourths watts per candle, should stand a gradual increase of pressure of direct current up to 225 or 230 volts (now made 210) in three and one half minutes before the filament breaks; that when slowly and regularly raised in two and one half minutes to say 170 volts, that is, approximately three fourths of the mean breaking voltage previously alluded to, and afterwards retested at ordinary voltage, the candle-power should not be less than 14.4 nor higher than 17.6, while the watts per candle should not exceed four." Among other results he states that lamps from three to four watts per candle give the greatest candle-power per lamp, from 700 to 1000 hours, with the least expenditure of energy per candle; even when the price of a kw-hour is as low as 6 cents the high efficiency lamp has to give way to those of three to four watts per candle; at the rate of 18 cents per kw-hour the lamps occupy relatively the positions indicated by their initial efficiencies. Regarding high efficiency lamps, he states that if they could be relied upon to start at their marked candle-power they would be good for domestic lighting and for large open spaces where considerable reduction in candle-power would not cause inconvenience, but in an establishment like the post-office they could not be tolerated. The paper is concluded with a copy of the specifications of the Post-Office, which, however, he does not consider to be in its final form (this specification is reprinted in full in another column). He states that his tests have proved to be a valuable means for finding out the good, bad and indifferent qualities of lamps; they give a good forecast of what the lamps will do when used in the ordinary way. In the discussion which is reprinted, Prof. Ayrton, among other things, remarked that he had recently made life tests on lamps whose filaments are made of carbide of silicum, which lamps are not yet before the public; he spoke very highly of them and stated that after 1000 hours the consumption was not greater than 3.75 watts per candle. He found, by an induction coil, that the lamps in which the light improved were those in which there was an improvement in the vacuum, and generally speaking, lamps in which the candle-power rises are incomplete. Fleming did not endorse the standard of light which was adopted in the specification, nor the photometer; photometry was not a question of instrument, but one of observer; the Hefner lamp was too red to be a standard, but the Harcourt lamp was of very great value; for secondary standards he had adopted 16-cp filaments in large bulbs, and they answered very well; he thinks the specifications should have stated what position the filament was to be placed in, with respect to the voltmeter; the specifications should be further discussed before final adoption, as it might otherwise deal very differently with different classes of lamps. Swan thought the short test described would give very valuable information. Webber thought the specification would be very good if minor alterations were made; he thinks the normal watts per candle should also be marked on the lamp. Preece in referring to the discussion said that the alternating-current had no different effect on the lamps; he intends to adopt the recommendation of Fleming. The paper is discussed editorially in the Lond. *Elec.*, Oct. 2. It is questioned whether the number of lamps which are to be taken as a sample is sufficiently great; nothing is said in the specification about the position of the lamp in the photometer or whether the candle-power is to be measured in one direction or is to be the mean spherical; these details may affect the candle-power to the extent of 30 per cent.; the standards of light to be used open up a fruitful source of dispute; under such imperfectly defined tests, lamps selected at random might be passed in one place and condemned in another; regarding the test for endurance, the question arises whether the increased voltage tests is the best means of deciding what the normal behavior of the lamps will be in practice; such tests might be unfair to thin film lamps; more proof is wanted before it can be said that a lamp which fails to pass this high-voltage test will necessarily be worse than one which passes it; a lamp might protect itself against the effect of over-pressure by increasing in resistance; the final candle-power measurement would also depend on the way in which the increased pressure was applied; it is thought that the specification might well be held in suspense for a time until some of these questions have been further discussed.

Tests of the Jandus Arc Lamp. Lond. *Elec. Rev.*, Oct. 2.—A reprint of the results of tests made by Koerting and Mathiesen in Germany, which are very unfavorable to the lamp, and do not agree with the results obtained by Houston & Kennelly; the results of these tests were noticed in the *Digest*, June 27; see also Aug. 22 and Sept. 12.

Incandescent Lamp Tests. PREECE. *El'ty*, Oct. 14.—The beginning of an abstract of the B. A. paper noticed above.

Arc Lamps and Supports. *West. Elec.*, Oct. 10.—A reprint of a number of the illustrations from *L'Energie Elec.*, noticed in the *Digest*, Oct. 10.

POWER AND HEAT.

Welding of Pipes. MACCARTHY. Lond. *Elec. Rev.*, Oct. 2.—A brief editorial review of a recent paper before the Institution of Mechanical Engineers; he described the Benardos arc process, which has been in constant use for over five years for this purpose and has already given very satisfactory results; (this process has already been described in these columns); subsequent turnings proved that the welding has been perfect and that the metal has not been burned or rendered brittle.

Electric Elevators in Germany. *L'Ind. Elec.*, Sept. 25.—Illustrated descriptions of some of those in use, one of which, in Dresden, is operated by a three-phase motor.

Laboratory Furnace. WALKER. *Am. Gas Light Jour.*, 64, page 610.—A description of an apparatus which can be obtained in almost any laboratory, with which Moissan's experiments may be repeated in the labora-

tory on a small scale ; the melting of quartz and the reduction of manganese may be readily carried out.

TRACTION.

Prevention of Electrolysis. Mommerque. *L'Eclairage Elec.*, Oct. 3.—The beginning of an article of a general character; the present portion is rather elementary and appears to contain nothing new; he bases his subsequent discussion on bonding in which the copper bonds have such a diameter that their linear resistance is equal to that of the rails.

Disturbances Due to Railway Currents. Van Vloten. *L'Elec.*, Oct. 3.—The beginning of a reprint of a report made to the International Railway Union which recently met at Stockholm; the present portion appears to be a summary of some of the more important recent papers and seems to contain nothing new.

Railways in France. *L'Eclairage Elec.*, Sept. 26.—A short article giving some statistical information concerning the electric railways in France constructed by the Thomson-Houston Company.

Sectional Contact System. Diatto system. *L'Ind. Elec.*, Sept. 15.—An illustrated description of this system; the inventor estimates the cost to be from $3400 to $4800 per kilometre (this system was described some time ago in these columns).

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Statistics for Switzerland, 1894 and 1895. Denzler. *Elek. Zeit.*, Oct. 1.—A reprint from a Swiss journal, including a number of interesting tables. Among the general results shown are that the largest increase has been in central lighting stations; that the distrust in accumulators which has been such a serious barrier to their adoption is becoming less and less, and that of 189 new lighting installations 87 contain batteries; that the application of electric energy for power purposes has developed very rapidly; the number of motors connected to central-station circuits during this time increased from 193 to 576, and that besides this 479 generators and motors of a total of nearly 12,000 kilowatts have been installed; approximately this amount is greater than the total power represented by steam, gas, petroleum and benzine engines which have been installed in Switzerland during that time, exclusive of locomotives and marine engines; the continuous current still takes the lead; the continuous and the single-phase alternating systems are used most frequently where the current is used chiefly for lighting, while the two-phase current is used when lighting and power are of about an equal value, while the three-phase system is used when the consumption for power is the more important; in some of the later large transmission installations the continuous-current series system has been used; most of the alternating-current transmission systems are on the three-phase system; this system is also gaining ground for stations supplying both power and light, as the improvements on the motors have been such that the systems have the combined advantages of the two-phase system for light and of the three-phase system for power without having the accompanying disadvantages.

Frankfort-on-the-Main. Elec. Zeit., Oct. 1.—A communication criticising severely the statements recently published regarding the operation of this station (see *Digest*, Sept. 26 and Oct. 17) and claiming that, in the way they were stated, they lead to incorrect results; a comparison on a fair basis with the installation at Cologne is given, from which any one can draw his own conclusions.

Bristol. Blaikie. Lond. *Elec. Eng.*, Oct. 2.—A reprint of the recent paper descriptive of the station, including the plans; it is an alternate-current station in which the transformers are in underground substations.

Gas Engine Driven Installation. Lond. *Elec. Rev.*, Oct. 2.—The operating data of a station at the Empire Theatre.

Charging for Current. *Elek. Zeit.*, Oct. 1.—An editorial endorsing and recommending a system of charging recently adopted by a central station in Germany; it is thought to be an important step toward the ideal system. A difference in the charge, depending on the application of the current, was abandoned, and instead, the price was made dependent on the amount of time during which it was in use. The price of the energy recorded by the meter is made 12.5 cents per kw-hour for the use of all the installed apparatus for an average of 400 hours a year; the increase over this amount in the year is charged for at the rate of 0.5 cent per kw-hour; for 400 hours, therefore, the current would cost 12.5 cents per kw-hour, while for 3000 hours it would be only 2.1 cents per kw-hour; this system is advantageous both for the consumer and the station.

Cheapest Electric Lighting Plant in the World. *Eng. News*, Oct. 8—A rather full description, under this title, of the municipal water power plant at Johnson, Vt., where it is thought that electric light is being furnished at as small a cost as would be possible under favorable conditions anywhere; the machinery consists of a vertical 45-hp turbine run from an abandoned dam; it is coupled to a 750-light alternator operating at 1000 volts; the street lamps are connected 53 in series; the station is run only during the hours when the light is needed; there are about 900 lamps connected to house circuits; the first cost in round numbers was $5600, of which the principal items are given; only one man is employed, at a salary of $425 per year; the operating expenses and interest charges amount to $769 and the receipts from public and private lighting are $1200; this was for the first year's working; for the present year the net earnings will probably be between $500 and $600. The lowest cost is attributed to the following: That the water power at the turbine shaft costs only about $32 per horse-power; that the construction and operation is the most simple and economical, and that it is owned and operated by the village, making it perfectly secure from competition, and enabling capital to be secured at a low rate of interest.

WIRES, WIRING AND CONDUITS.

Concentric Cables. Lond. *Elec. Rev.*, Oct 2.—An editorial review and criticism of the article by Hetherington (see *Digest*, Sept. 12); a disagreement is expressed with some of the opinions, although the article as a whole is endorsed. It is said in the original article that there is a tendency in England to use lead-covered cables, and that copper is being superseded by cheaper compounds of oil and fibre ; this, it is claimed, is not warranted, as lead-covered cables by no means hold the market, nor are they used at all on some of the recent systems ; rubber of good quality is very nearly as cheap, and certainly as reliable ; failure or success is as much a question of laying and maintenance as anything else, and with drawing-in systems the flexibility of armored rubber concentric cables makes them preferable to lead-sheath compound cables. The old Ferranti mains between Deptford and London are being replaced by cables.

Calculation of Wires. Blondel. *L'Eclairage Elec.*, Oct. 3.—A reprint of the article abstracted in the *Digest*, last week.

ELECTRO-PHYSICS AND MAGNETISM.

Röntgen Rays. *Proc. Lond. Phys. Soc.*, September.—The foreign abstracts contain a large number of abstracts on Röntgen rays, most of which have already been noticed in these columns, while others belong to the subject of pure physics. Among these it is stated that Sandrucci is said to have arrived at the conclusion that the photographic effect of Röntgen rays is direct and not due to fluorescence; Lussana and Cinelli show that the law of inverse squares is obeyed only within certain limits of distance, beyond which the variations are greater than the law would indicate, and at smaller distances, less; Eder and Valenta showed that there was no shortening of the exposure by using orthochromatic plates or laying a fluorescent screen on the plate; heating the film to 50 degrees C. shortened the exposure.

X-Ray Radiation. S. P. Thompson. Lond. *Elec. Rev.*, Oct. 2.—A correction of some misstatements in the report of his discussion at the B. A. meeting. What he stated was that he had found that at high exhaustion two sets of shadows were simultaneously produced, one inside of the tube on its walls and the other outside on the screen; they differ in that the latter remains unaltered in shape and position while the former is being distorted or shifted by electrostatic or magnetic influences; both sets of shadows are present at the same time.

Electric Images in the Field of a Crookes Tube. Oumoff and Samoiloff. *Phil. Mag.*, October.—Descriptions of experiments in which the fluorescent screen was replaced by one of ebonite, which, after a short exposure, was dusted with sulphur and minium, when the images formed appeared in red and yellow. They come to the general conclusion that the phenomena observed should be attributed to the electrical fluxes proceeding from the tube and the objects in its neighborhood, together with a dielectric polarization.

Crookes Tube With an External Armature. Semmola. *L'Eclairage Elec.*, Oct. 3.—A translation from the Italian, describing experiments with a tube which had a band of tin around the outside of the pear-shaped bulb, and connected to earth, but not connected with either of the electrodes; he showed that the effect of this armature was to increase the intensity of the rays.

The Bending of X-Rays Behind Opaque Bodies. Villari. *L'Eclairage Elec.*, Oct. 3.—A reprint of his article which was noticed in the *Digest*, Oct. 10.

Discharge of Bodies by X-Rays. Villari. *L'Ind. Elec.*, Sept. 25, and *L'Eclairage Elec.*, Oct. 3.—A reprint of an Academy note.

Emission of X-Rays. Guillaume. *L'Ind. Elec.*, Sept. 25, and *L'Eclairage Elec.*, Oct. 3.—A reprint of an Academy note discussing the law of emission.

X-Rays. Lond. *Elec. Eng.*, Oct. 2.—A summary of the discussion at the B. A. (see *Digest*, last week.)

Origin of Contact Electricity. Pellat. *L'Eclairage Elec.*, Sept. 26.—A brief criticism of the recent articles of Christiansen (see *Digest*, May 9) ; Pellat shows that the statements are in contradiction with those obtained by other experiments, and especially with those found by him.

Electric Potential in a Liquid in Movement. Villemontee. *L'Eclairage Elec.*, Sept. 26.—A conclusion of his long article.

Admittance and Impedance Loci. Bedell. *Phil. Mag.*, October.—A reprint of the Physical Society paper noticed in the *Digest*, last week.

Influence of Light on the Sparking Discharge. Warburg. Lond. *Elec.*, Oct. 2; abstracted briefly from *Wied. Ann.*, No. 9.—He shows that if the discharge potential is gradually applied illumination has practically no effect on it; it is only with sudden applications or alterations of potential that illumination has a facilitating effect; there is some process at

present unknown which precedes discharge, and it is this process which is shortened by illuminating the cathode. The range of potentials at which discharge may or may not take place in the dark is much narrowed by illumination, hence a telephone in circuit with a spark gap will give an impure note in the dark and a pure and higher one in the light.

Apparatus for Studying the Properties of Electric Waves. BOSE. Lond. *Elec. Rev.*, Sept. 25 and Oct. 2.—A reprint of his B. A. paper. It is being reprinted in *Elec'ty*, N. Y.

Magnetic Hysteresis in a Rotating Magnetic Field. BEATTIE and CLINKER. Lond. *Elec.*, Oct. 2; a reprint of a B. A. paper.—A description of an investigation in which they measured the hysteresis loss in iron in a rotating magnetic field, a method which has been employed by many for quick workshop tests of transformer iron; the apparatus was suggested by Fleming; any sample of iron may be tested, whether in the form of discs, wires, or filings, the sample being placed in a cylindrical bucket which was suspended in the revolving magnetic field, the deflections of the suspended bucket being measured, the counterforce being the suspension wire, which was calibrated by a vibration experiment with a bar of known inertia moment; the presence of eddy currents could be detected readily by varying the speed; an illustrated description of the apparatus is given, as also the curves showing the results of the tests. Ewing found that the deflection obtained in his instrument is not proportional to the number of strips in the revolving bundle; they therefore made tests to see whether the shape of the curve would be the same for circular discs as for strips, and to arrive at an explanation. They also found that the hysteresis did not decrease at high inductions; above 16,000 to 17,000 lines per square centimetre hysteresis begins to diminish. They also compared with each other the results of hysteresis measurements made by the rotating field and by the ballistic method; by the latter method they found that the hysteresis was strictly proportional to the 1.6th power of the induction; with a rotating field method they obtained almost identical results, but they were found to depend on the length of the specimen, which was wound with the exploring coil; the induction is much greater in the centre of the sample than toward the ends, and it is not right to take the mean value; a method is described for obtaining the proper equivalent induction on the basis of the law of the 1.6th power, the value for the reduction factor being found to be about 0.8; on applying this correction the values agreed closely with those of the ballistic tests. The mean of their values of the hysteresis loss for an induction of 2500 and a frequency of 100 was 0.63 watt per pound. The rotating field method loses much of its apparent simplicity on account of the difficulty of obtaining the true induction, especially in small specimens, but their results lead them to believe that with a better knowledge of the distribution of the induction the method could be made more expeditious and quite as accurate as the ballistic method; with thin cylindrical specimens about 4 cm long an approximate value of the equivalent induction can be obtained by multiplying the maximum by 0.8.

Magnetic Hardness. KOHN. *Lond. Phy. Soc.*, September; abstracted from *Wied. Ann.*, 58, page 527.—He endeavored to find the screening effect of various kinds of iron and steel against magnetic induction; he found that ferric chloride solution and perfectly soft wrought iron exert no screening action on the magnetic lines of force and may therefore be regarded as mechanical soft bodies, but a steel tube diminishes the field due to the conductor and it does so to a greater extent as the current decreases; the thicker the wall, the greater the screening effect; the mechanical hardness corresponds to magnetic hardness.

Energy of Magnetization. KLEMENCIC. *Proc. Lond. Phys. Soc.*, Sept.; abstracted from *Wied. Ann.*, 58, page 248.—He determined the loss of energy by hysteresis and eddy currents for much higher frequencies than the usual, which were obtained by discharging a condenser through a self-induction coil; the amount of damping produced by the iron in the coil was determined by finding the curve of discharge by means of a magnet and break operated by a falling weight; in soft iron he found the hysteresis loss considerably exceeded that observed at lower frequencies, while for steel and nickel the amounts were practically the same; for soft iron wire 0.02 cm thick the hysteresis loss was 38,000 ergs calculated from the hysteresis loops.

Phenomena of Magnetism. ROSING. *Phil. Mag.*, October.—A long, mathematical article on the possibility of explaining the phenomena of magnetization by the hypothesis of the participation of matter in the motion of the magnetic field; he assumes as a possibility that matter when magnetized is put into the same motion as the surrounding magnetic field.

Magnetic Behavior of Iron, Nickel and Cobalt Amalgams. NAGAOKA. Lond. *Elec.*, Oct. 2; abstracted from *Wied. Ann.*, No. 9.—He found, with dilute amalgams, that their magnetic intensity shows a maximum at their melting points and that during the melting there is a sudden change which is not observed during solidification.

Röntgen Rays in Detecting Adulteration. Elec. Jour., Oct. 1; reprinted from the *Druggists' Circular*.—A short note referring to some recent experiments of Arnold, made to detect admixtures of foreign substances in food. Although carbo-hydrates, fats and aniline colors are transparent to the rays, yet there are small differences. Vegetable oils may be classed as follows: Castor, almond, olive, poppy, sesame and cottonseed; the difference between the second and fifth are scarcely noticeable, while castor oil is considerably more transparent than the others; butter is the least transparent of the fats, after which comes lard, the most transparent being margarine.

The Earth a Great Magnet. FLEMING. *El'ty*, Oct. 14—.An abstract of the recent lecture noticed in the *Digest*, Oct. 17.

ELECTRO-CHEMISTRY AND BATTERIES.

Manufacture of Chlorine. MOND. Lond. *Elec. Rev.*, Oct. 2; a brief editorial review of his B. A. paper.—He treats the subject historically; only two electrolytic works producing chlorine on a really large scale are in operation to-day, in both of which chloride of potassium is used; these works are at Stassfurt, Germany; there are a considerable number of smaller works in existence or in the course of erection using various methods, the most interesting of which he says is that of Castner; there is an entirely different class of methods in which it is proposed to electrolyze chlorides of the heavy metals, either as obtained in metallurgical operations or specially prepared for the purpose, among which he mentions that of Hoepfner; both products of electrolysis are obtained, namely chlorine and the zinc or copper or other metal, and thus all secondary reactions, which have been the great difficulty with alkaline chlorides, are avoided; these new processes must still stand the test of time. He urges chemists to solve the problems by purely chemical means, believing that there is plenty of scope left in that direction.

Electrolysis of Chloride of Sodium. L'Elec., Oct. 3.—An extract from an article in a French paper in reference to the Solvay electric process. In electrolysis of chloride of sodium there is also produced hydrogen, which is mixed with chlorine, but its presence it is claimed does not interfere with the absorption of the chlorine by the chalk in the present process; it is also necessary to avoid the explosion of a mixture of these gases, which is done by passing the hydrogen which is left after the absorption of the chlorine back into the space above the tank until the proportion of hydrogen is sufficiently great that no spontaneous explosion need be feared.

New Use of Carborundum. Lond. *Elec.*, Oct. 2.—Luermann in a German journal suggested that it could be employed as a source of silicon in the manufacture of steel, as it is soluble in molten steel; a considerable market for this material would arise if thus used; as the product as at present obtained is heterogeneous, that which is unfitted for abrading purposes may be found a profitable bi-product as a carburetting and siliciding agent.

Desilverization of Lead. TOMMASI. *L'Eclairage Elec.*, Oct. 3.—The beginning of a long, general article on the subject, in the present portion of which he describes the three known non-electrical processes in use for obtaining the silver from lead ores.

Report of the B. A. Committee on Electrolysis. SHAW, FITZPATRICK and WHETHAN. Lond. *Elec. Rev.*, Oct. 2.—A brief report, containing no information of any value.

Applied Electrochemistry. SWINBURNE. Lond. *Elec. Eng.*, Oct. 2.—The conclusion of his second lecture (see *Digest*, last week).

New Method of Electroplating. Sc. Amer., Oct. 10.—An extract from a London daily paper describing very briefly what is claimed to be a new process to do away with the wiring of the pieces, requiring no "moppers" or polishers, and enabling three or four times the amount of work to be turned out in the same time; the system has been in operation in London for some months; it is applicable to small objects, which constitute 75 per cent. of all the articles plated. The articles are placed in large quantities in a revolving hollow insulated retainer in quantities up to 90 or 100 pounds, and this retainer is made to revolve in the bath while the deposition is taking place, the revolutions being 15 to 50 per minute; the anodes are suspended in the bath outside of this revolving part, and the other terminal enters the retainer.

Applied Electrochemistry. SWINBURNE. *Elec. Jour.*, Oct. 1. The beginning of a reprint of his Cantor lectures (see *Digest*, Oct. 10 and 17).

UNITS, MEASUREMENTS AND INSTRUMENTS.

Rewstene; a New Resistance Metal. HARKER and DAVIDSON. Lond. *Elec. Rev.*, Oct. 2; a reprint of a short B. A. paper.—Their object was to find an alloy which has a higher resistance than iron, a moderate temperature coefficient and a high current-carrying capacity. The composition of the alloy is not given; the average specific resistance is about 45 to 46 as compared with copper as unity, and this "seems to be independent of the size of the wire"; the temperature coefficient is 0.0011 per ohm per degree C., and remains almost absolutely constant from 0 degree to 60 degrees; at 500 degrees there was a slight falling off in the coefficient above 100 degrees. On heating the wires with comparatively large currents, only a very small variation in the permanent resistance was found; only when fine wires were heated to a full red heat could any serious change be detected; oxidation does not occur to an appreciable extent below 25 degrees C.; this material is soft, will stand considerable twisting and its mechanical properties are only slightly influenced by the passage of a current; when protected from oxidation the resistance is scarcely altered by exposure to a red heat; the alloy can be soldered with the ordinary soldering or brazed.

Hefner Standard Lamp. L'Ind. Elec., Sept. 25.—A translation in full of a recent communication from the German Reichsanstalt to the Geneva

Congress. It gives a complete, illustrated description of the lamp and instructions regarding its use; the description gives all the necessary measurement of the lamp. The intensity of the standard German paraffine candle with a height of flame of 50 mm is given as 1.2 Hefner lamps; that of the standard English candle with a 45 mm height of flame is given as 1.14 Hefner lamps; the latter figure is a mean of a number of determinations by different parties, which are given in a foot note.

Dimensions of Electric and Magnetic Units. Joubin. *Proc. Lond. Phys. Soc.*, September.—An abstract of a paper from the French Physical Society, in which he assumes the units introduced in the electrostatic and electromagnetic systems to be of a purely mechanical nature.

Capillary Electrometer. Meyer. *Proc. Lond. Phys. Soc.*, September; a long abstract from the *Wien. Ber.*, 105, page 139.—A discussion of the two theories offered for the explanation of the capillary electric phenomenon.

Self-induction Standards. Wien. *Proc. Lond. Phys. Soc.*, September; abstracted from *Wied. Ann.* 58, page 553.—An abstract of the article noticed in the *Digest*, Sept. 12.

Electrostatic Voltmeter. Dujon system. *L'Elec.*, Oct. 3.—An illustrated description of a form which resembles in principle the multi-cellular quadrant electrometer of Lord Kelvin.

Electrometers. Armagnat. *L'Eclairage Elec.*, Sept. 26.—A long article n the form of a general treatise on the subject, being apparently a continuation of the series of articles on such measuring instruments. (See *Digest*, Oct. 3.)

Polarization and Resistance of Batteries. Streintz. *L'Eclairage Elec.*, Sept. 26; abstracted at some length from *Wied. Ann.*, 57, page 711.—He shows experimentally that all the methods of measuring polarization while electrolysis is taking place are not beyond criticism.

Best Form of Cross-Section for Galvanometer Coils. Laws. *Tech. Quart.*, June-September.—A short article showing how this cross-section may be determined for infinitely short needles, under the conditions that it should be the best form of cross-section when the currents of the instrument are independent of its resistance; that is, controlled by conditions external to the instrument; the cross-sections are shown when the condition is that of a given cross-sectional area and also when the condition is that of a given volume of coil.

The Ericsson Telephone.

During the past three years Ericsson telephones have been quietly introduced in this country and from all reports they have been giving very satisfactory service. Messrs. Smith & Patterson, 256 Broadway, New York, are the sole representatives in America of L. M. Ericsson & Co., Stockholm, Sweden, the manufacturers of the instrument in question, and recently the Ericsson Telephone Company, of New York, was organized to find a more extensive market for a telephone which will embody the Ericsson coal-grain microphone in its construction.

The Ericsson instruments, as will be noted by reference to the accompanying illustrations, are of characteristic design, differing materially in appearance from the types of telephones so familiar to the general public.

The coal-grain microphone (Fig. 1) is claimed to be one of the most sensitive and serviceable instruments ever designed. It is adjustable once for all time and never needs be touched. Its construction, while delicate, is such that it cannot get out of order, and it possesses the great advantage of requiring for its operation one half the battery power ordinarily used for telephones. It can be used in connection with any make of telephone, giving equal satisfaction in al cases whether used on long or short lines.

The desk set (Fig. 2) evidently has more care bestowed upon its construction than is usual with our own instruments, and it forms a very handsome outfit. The transmitter and receiver are mounted on one support in such relation with one another that when the transmitter is held in position before the mouth for conversing the receiver is by the same motion brought close to the ear, in position for receiving conversation. It is not necessary therefore for a person to assume any one position to use the instrument, the flexible cord permitting him to move about freely and yet be able to use the telephone at the same time. This instrument is complete with generator and bells, and rings through a resistance of 25,000 ohms.

In Fig. 3 is shown an exchange wall set. This instrument is designed for regular exchange work. It has a very powerful receiver, and is equipped with a reliable lightning arrester, etc., and can be used on either long or short circuits and on metallic or ground circuits.

Fig. 4 represents an interior set, especially adapted for use inside of buildings, such as factories, warehouses, etc. It has a battery-call device, the bell being of the vibratory type, and a call is made by simply pressing a button. The combination pattern of receiver and transmitter is used, and taken altogether it constitutes one of the most serviceable instruments in the market.

In this connection it may be of interest to state that over 300,000 Ericsson instruments are now in daily use in Europe, and it is stated that every telephone in Berlin is of the Ericsson type. The Japanese Government, it is also stated, has recently adopted this instrument in competitive tests with telephones of other makes. The Ericsson instrument is extensively used in Nor-

Fig. 1.

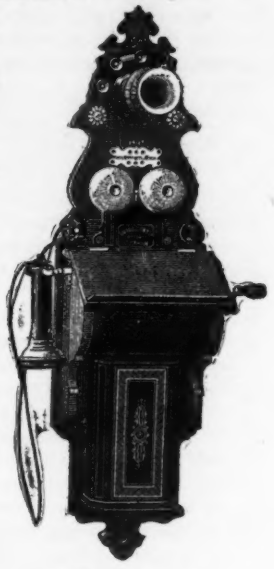


Fig. 3.

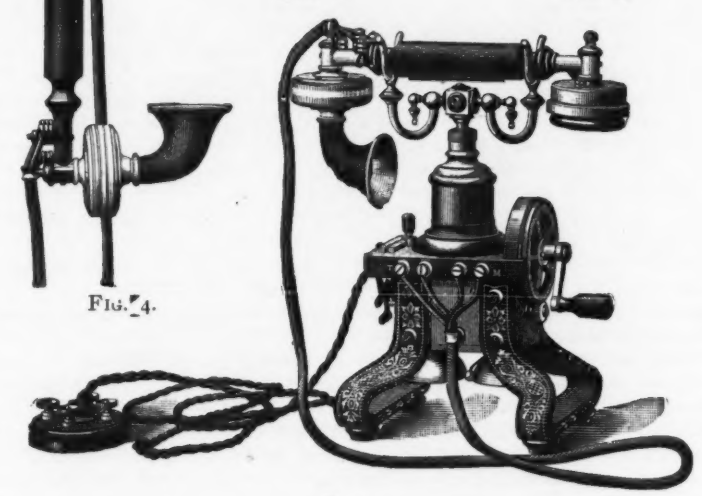


Fig. 4.

Fig. 2.

way, Sweden, France and Germany, and is, we are informed, meeting with growing favor in England.

In the United States over 250 different concerns are using Ericsson telephones with entire satisfaction.

Electric Elevators in the Siegel-Cooper Building.

Modern tall office buildings represent the highest excellence in the engineering science and mechanic arts, and as the interested visitor observes the various features of these structures he is deeply impressed with the evidences of advanced knowledge, skill and ingenuity displayed at every turn. Generally speaking, above ground the architect's work is more in evidence; below ground, the engineer's.

Concurrent with the rapid improvement in every branch of industrial art applied in the planning and construction of these huge structures, electrical engineering has kept abreast of the extraordinary requirements, with the result that the electrical features in these buildings illustrate in every detail the highest refinements of the industry. Their electrical plants are modern and complete and excite the admiration of all interested.

In this connection there is one fact that stands out more prominently than all others; it is that if it were not for the elevator service tall buildings would probably not exist. It is really the elevators that render them commercially profitable to their owners, for the reason that no one could be induced to rent offices on the higher floors were they compelled to climb stairs. The service, moreover, must be rapid, so that no time shall be lost in reaching the highest elevations. To meet these exacting requirements fast electric elevators were developed, and how satisfactorily these machines answer the purpose is evident to every one who has ever entered buildings of this class.

The Sprague electric elevator is very extensively used in modern office buildings, and for tall structures the type in use is known as the multiple sheave horizontal machine. This particular type has been fully described. In buildings of ordinary height the intermediate type of machine finds its application. This machine is of the drum type, and the purpose of this article is to describe an installation of this class of eleva-

tors, which is unquestionably the largest electric elevator plant in the world, namely, that of the Siegel-Cooper Building, Sixth Avenue, New York.[1]

This magnificent building, which was recently opened for business, is six stories in height, and is equipped with 21 Sprague electric elevators of the intermediate type. Ten of them are for passenger service, the rest being used for the various purposes in connection with the transaction of the business, such as carrying employees, packages, freight, etc.

In addition to this equipment, the Sprague Electric Elevator Company has just closed a contract to install two more elevators, which will increase the total number of machines to 23.

The various elevators are scattered throughout the building, in groups and singly, the largest group being that of the eight passenger machines which are located in the centre.

A plan of the arrangement of these elevators is shown in Fig. 1, which also shows the disposition of the nine generating units, the position of the switchboard, etc.

The restaurant elevator is of the Y type, and runs from the sidewalk, on the Nineteenth Street side of the building, to the restaurant. The rise of the platform is 13 feet, its speed is 60 feet per minute, and its lifting capacity about 1200 pounds.

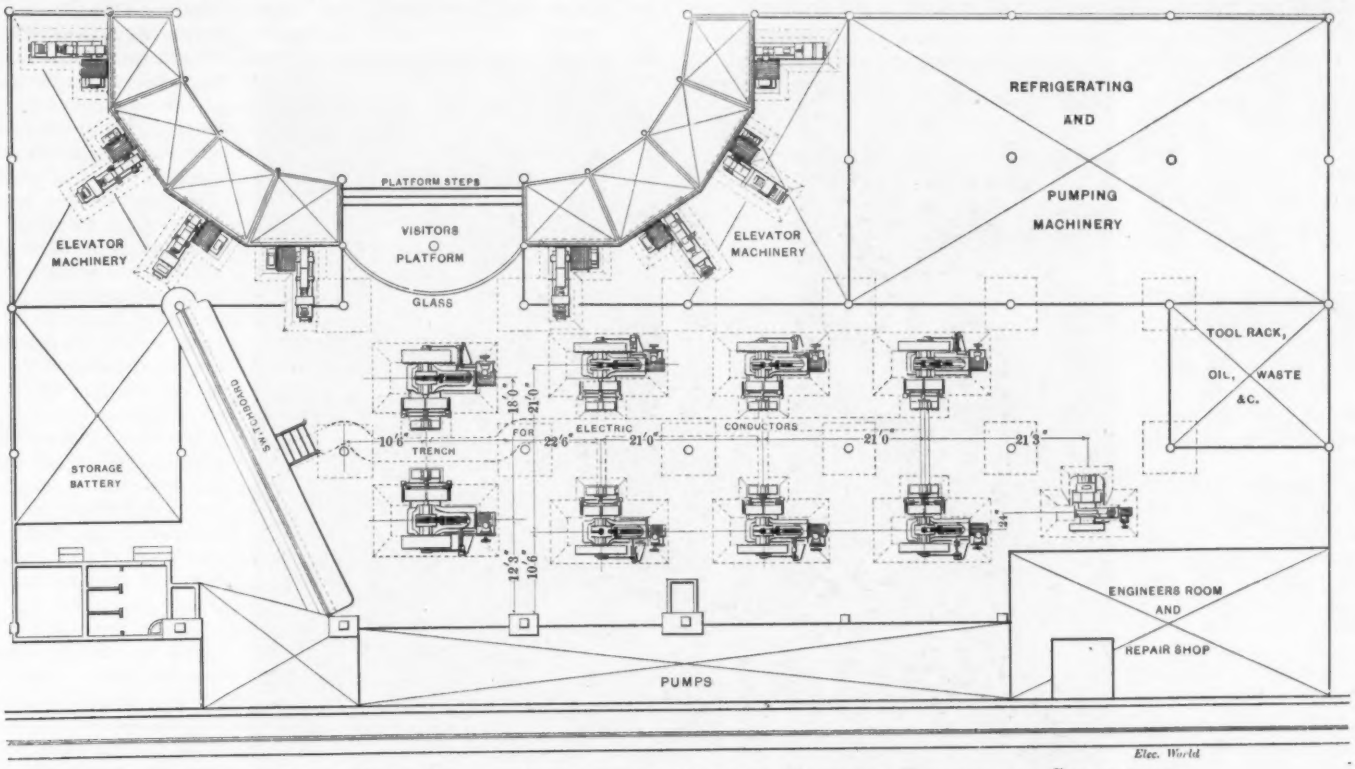


FIG. 1.—FLOOR PLAN, SHOWING LOCATION OF ELEVATOR MACHINES, ENGINES AND GENERATORS.

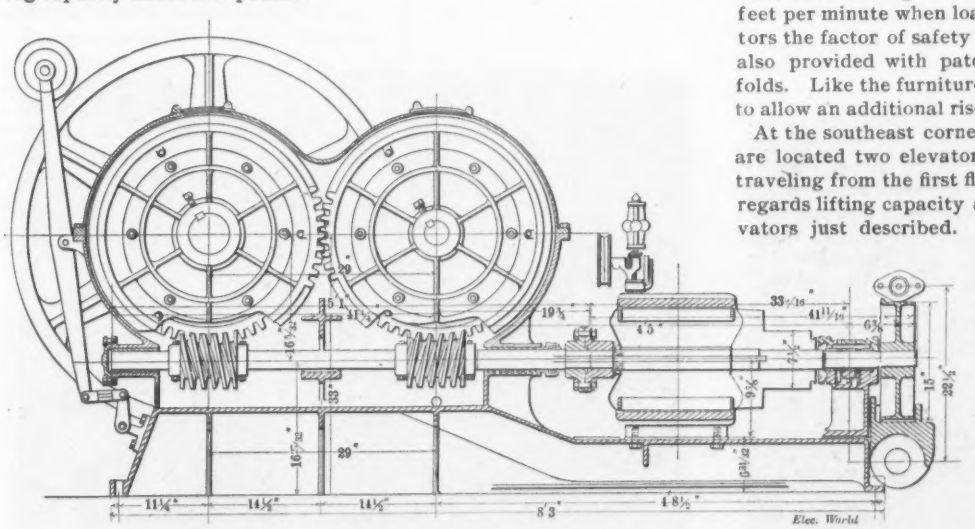


FIG. 2.—ELEVATION VIEW OF ELEVATOR MACHINE.

The three elevators used by the shipping department, also of the Y type, have platforms 3 feet 6 inches by 10 feet in dimensions, and are made extra strong and heavily braced. Their speed is 80 feet per minute each, and their lifting capacity 1500 pounds. Two of them run from the shipping department in the basement to the sidewalk, a distance of 10 feet; the third one running from the floor of the sub-basement to the sidewalk, a distance of 17 feet. The opening of each elevator in the basement is provided with an automatic sliding gate manufactured by the Excelsior Hatch Company, New York.

The furniture elevator is of the Z type, and has a very large platform. It runs from the shipping department in the basement to the sixth floor, on the Nineteenth Street side, the mechanism being located in the sub-cellar below the shipping department. It rises to a height of 95 feet, and has a lifting capacity of 5500 pounds. When loaded with an average load of 4000 pounds its speed is 200 feet per minute. The platform is 12 feet by 16 feet, and provided with patent folding gates at the front and rear, the sides being enclosed. This elevator is designed to safely sustain the load imposed with a factor of safety of five. The drum of the elevator is designed to allow the car to rise about 30 feet more than the height named, thus permitting of future extension.

Three freight Z-type elevators are located at the northeast corner of the building. Two of them run from the shipping department to the sixth story, representing a rise of 95 feet, and one from the floor of the sub-cellar to the roof, a distance of 150 feet. They are all of the same size, each having a lifting capacity of 5500 pounds and a speed of 200 feet per minute when loaded to 4000 pounds. In the case of these elevators the factor of safety is five, as in the furniture elevators. They are also provided with patent folding wrought iron gates opening in two folds. Like the furniture elevator these machines are so constructed as to allow an additional rise of 30 feet.

At the southeast corner of the building on the Eighteenth Street side are located two elevators of the Z type, for the use of employees only, traveling from the first floor to the sixth floor, a distance of 86 feet. As regards lifting capacity and speed they are the same as the freight elevators just described. The size of the platforms is 11 feet x 11 feet. They are also fitted with automatic folding gates. The drums of these elevators are designed so that the travel of the car may be extended to the roof. Although built for a maximum load of 5500 pounds, or 40 passengers, these cars have carried 58 people, or about 7200 pounds.

The eight main passenger elevators are located in the centre of the building arranged in a semi-circle. They are of the Z type and run from the basement to the sixth floor, a distance of about 100 feet. Each has a speed of 200 feet per minute when loaded to full capacity, which is about 4000 pounds. The cars are constructed of ornamental oxydized wrought iron, highly finished, and on the inside are narrow beveled plate mirrors and corner posts of nickel plate brass neatly and artistically wrought. Each car is provided with double folding iron gates.

Two other passenger elevators of the Z type are located one on each side of the main entrance at the Sixth Avenue end of the building, and run from the first floor to the sixth floor, a distance of about 96 feet. Their

[1] See THE ELECTRICAL WORLD, Feb. 1, 1896, p. 128.

speed is about 250 feet per minute when loaded to full capacity which is about 2500 pounds. They are counterparts of the main passenger elevators. The machines of these two elevators are situated on the fourth floor, this disposition of the same being rendered necessary on account of the unavailability of the space in the basement; that would naturally be utilized for this purpose.

A package elevator on the Eighteenth Street side of the building near the main passenger elevators rises from the basement to the sixth story. It is of the Y type and has a speed of 250 feet per minute and a carrying capacity of 1200 pounds and is similar in all respects to the freight elevators above referred to. The platform measures 3 feet by 5 feet. This elevator is used for the purpose of carrying small parcels from floor to floor, the entrances at each floor being closed by doors hung on weights, the doors opening and closing automatically.

The two additional elevators which are to be installed will be located at the rear end of the building, one on each side, adjoining the elevators already installed at these points.

Each elevator is equipped with the usual safety devices necessary for its safe operation. A description of the functions of these various devices will be interesting in this connection. The electro-mechanical brake is normally on when the machine is at rest, and operates reliably in starting, stopping, hoisting, lowering, or in case of failure of the main circuit; the centrifugal governor is connected directly to the screw shaft and operates at a determined speed to release the brake and stop the machine; the upper and lower limit cut-offs automatically cut off the current and operate the brake to stop the car at the top or lower landing in case of failure of the upper devices or the elevator operator to do so; the slack cable device cuts off the current and operates the brake in case the descent of the car is partially or altogether retarded, or is for any reason blocked in the shaft in descending; the automatic stop contact enables the operator to bring the regulator to the stop position and the car at rest in case he lifts his hand from the controller because of crowding, accident or carelessness. In this connection a fuller description of the elevator machinery will be of general interest.

The type Z machine is of the worm-gear double-drum class (Fig. 2), the two drums being mounted on opposite ends of a common spindle with tapered bearings, which is driven by two worm-wheels and right and left hand worms with interlocking spur-gears. The worm-wheels are of bronze accurately cut, and each is carried on a bisected machine-cut spur-gear. The worms are of steel, right and left handed, cut with double pitch and of the Hindley type, so as to give a large amount of bearing surface. The worm and spur-gears run in the same gear case and in oil.

The motor is self-oiling and of sufficient capacity to start smoothly, running economically and uniformly at a speed not to exceed 800 revolutions per minute. It is compounded, and, no matter whether it takes current from or gives it to the line, is designed to temporarily stand an overload of 25 per cent.

The armature is of the ironclad type, has an over-sleeve and is securely keyed to the main screw shaft. It is removable through the yoke at the rear end of the machine. It is furnished with double brush-holders on each side of the commutator, permitting the removal of any brush while the machine is in operation. The brush-holders have a capacity for carrying the maximum current without heating and are provided with tension devices which secure a steady and uniform adjustable pressure on the commutator and prevent flashing under any conditions.

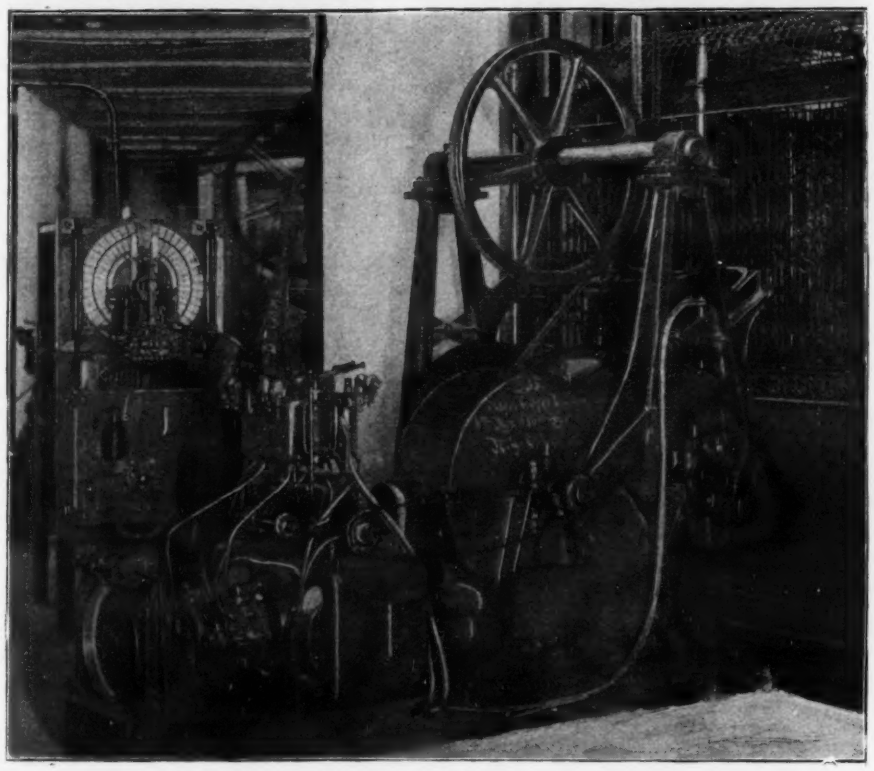


Fig. 5.—Passenger Elevator Machine and Controller.

The field magnets are constructed of a special grade of steel.

The rheostats and all other starting and current-carrying devices are mounted on incombustible bases.

The main brake consists of an accurately turned flanged pulley carried on the screw shaft. It is suitably anchored and is under continual spring pressure to close. It is released by a special circuit which opens and allows the brake to come on at both limits of travel and when running down too fast; also when stopped by the operator. On failure of current for any reason or when running at an excessive speed, the brake becomes instantly operative.

The Y type of the Sprague elevator is of the single-worm gear-drum design, the drum being mounted on a spindle with ample bearings and driven by a worm-wheel and worm. The worm is of bronze, cut with a single pitch, and with the worm-wheel runs in the same gear case and oil. The thrust is taken up by ball-bearing thrust-plates running in oil. The electrical mechanism is the same as that of the type Z machine.

As a remarkable test of the efficiency of the elevator system, the entire plant has been run on continuous service with heavy loads on an average of 100 electrical horse-power, and arc and incandescent lamps are run in the same circuit as the elevator without disturbance.

Considering the number of elevators, the loads, speeds and distances of transmission, the plant is the largest in any single building, and the most economical in existence.

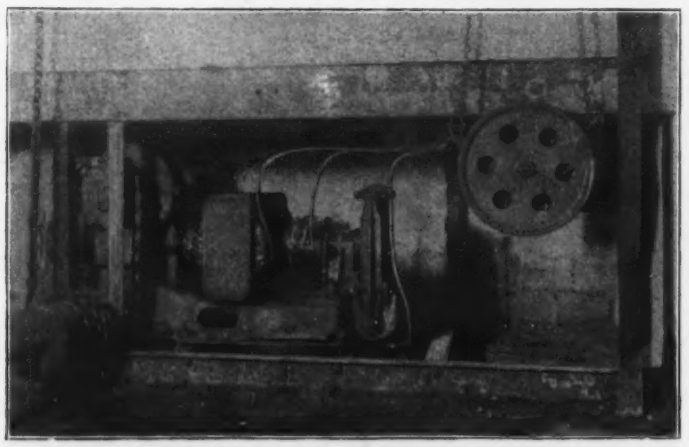


Fig. 3.—Freight Elevator Machine.

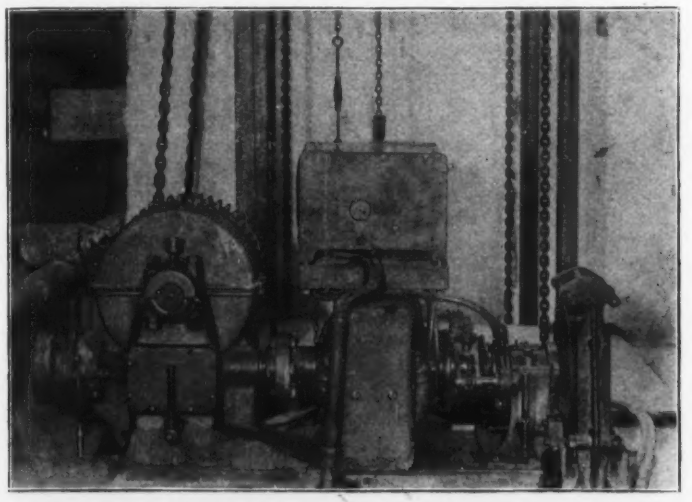


Fig. 4.—Sidewalk Elevator Machine.

Figs. 3, 4 and 5 represent one of the freight elevators, the sidewalk elevator, and one of the passenger elevators, respectively. In the latter view one of the cars is partially shown.

Charging for Electric Current on the Wright Demand System.

BY R. S. HALE.

The expenses of an electric company are of two kinds, of which the first consists of the outlay up to the moment of supplying the current, and the second of the actual expense while supplying the current. The expense of getting ready to supply current, or the fixed expense, consists of interest, dividends, part of the labor, all the management and legal expenses, etc., while the coal bill forms almost the only item of expense for actually running the machinery. Now if the price per kw-hour be 15 cents and the customer burns his lamps one hour, the company gets 15 cents, of which 13 cents go for management, dividends, etc., while the balance goes for coal, etc. If the customer burns his lamps a second hour it costs the company nothing more for management or for interest or any of the fixed expenses, and if the company continued to charge 15 cents per kw-hour it would make a profit of 13 cents on a cost of 2 cents, or roughly 650 per cent. On the other hand, if the customer should burn his lights no longer than one tenth of an hour it would still cost the company 13 cents for interest, etc.; and though the coal, etc., for one tenth hour at 2 cents per hour would only be two tenths of a cent, the total cost to the company would be 13.2 cents per kilowatt against 1½ cents per kilowatt income, or a loss of 88 per cent.

The following example will show the method by which any company may easily determine the amount of its fixed and running expenses, for it must be remembered that even part of the coal bill, namely, the cost of coal for keeping up pressure in the pipes and for banking fires, this coal being used whether the engines run for 1 hour or 10, is a fixed expense.

Let us suppose we have a company which sold 9000 kw-hours in an average Summer month, July, for example, and that the expenses, including $\frac{1}{12}$ of the year's dividends, interest, etc., were $2300. In December the expenses ran up to $2510, while the company sold about 16,000 kw-hours, or 7000 kw-hours more than in June. The fixed expenses for management, dividends, etc., were of course more in December than in June, so that the $210 of extra expense in December was all running expense. As this extra expense of $210 was incurred in order to sell 7000 more kw-hours, the extra cost was only $210 ÷ 7000 kw-hours or 3 cents per kw-hour. If no current at all had been supplied in June, the company would then have saved only 9000 × 3 cents = $270, and its expenses would have been $2300 minus $270 = $2030, which would be the fixed expense per month. If it had supplied no current in December it would have saved 16,000 × .03 = $480, and its fixed expenses would have been $2510 minus $480 or $2030, or just the same as in June. A plant of this size would be prepared, after allowing sufficient reserve, to supply a maximum demand of about 500 kilowatts. The fixed expenses are then $2030 ÷ 500 = $4.06 per month per kilowatt of maximum yearly demand or $48.72 per kilowatt per year. The result is that if a customer uses $\frac{1}{500}$ of the company's plant, in other words, if he burns lights equal to 1 kilowatt at one time, he costs the company $48.72 even if he burns them only one hour in the year, while after that one hour in the year it costs the company only 3 cents per hour more for each hour he burns them.

Now, in general, a company does not want to lose so much on one half its customers that it must charge an exorbitant rate to the other half in order to come out even. Yet it is apparent, from the above table, that if a company charges 20 cents per kilowatt hour to all customers, it loses from 80 cents to $1.80 on every 30-hour per year customer, and makes from 11 to 18 cents on every 10-hour a day customer. Of course, in particular cases the company may charge more or less than enough for a fair profit, as, for instance, when it wants to secure a particularly influential customer, or to have a use for plant that would otherwise be idle; but these are obviously only temporary expedients and it is apparent that some system of charging is needed which will draw a profit from the short-hour customers without making them feel that they are unfairly treated, and will give a low price to those customers who use their proportion of the plant long hours.

The Wright Demand System.—The Wright demand system is based on this principle.

It does not interfere with giving an extra discount to the customer who has a very large bill, since one big customer needs less clerical force and is in general less bother than ten small customers. But the Wright system assumes that each customer should pay the fixed expenses (including dividends, etc.) on the proportion of the plant that he uses, and in addition should pay running expenses only for the hours he actually uses the plant.

In order to accomplish this the watt-hour or ampere-hour meter is not sufficient, since the amount of plant required does not depend on the total number of kilowatt-hours but on the maximum current which is used at any one time. In order to show this and to show who are the long and short hour customers it is necessary to have in addition a demand meter to read the maximum current used by the customer at any one time during the year, for this is what determines the plant that must be installed at the central station in order to supply him.

Methods of Charging.—The kw-hours used by the customer being known from the watt-hour meter and the maximum current used at once from the demand meter, the matter of arranging the charges may be done in several ways. The three following will be found to cover nearly every case:

The first method is to make a list price per kilowatt, and then give say 10 per cent. discount to the customer who averages two hours' use of his demand, 15 per cent. discount for three hours' use, and so on.

The second method is to charge 15 cents per kilowatt for the first two hours and say 5 cents per kilowatt after this. We determine by the demand meter that a customer uses investment corresponding to three kilowatts, that being his maximum for the year, then 2 hours × 25 business days = 50 hours per month. His demand meter showed three kilowatts during the heavy load, hence he would be charged 15 cents per kw-hour up to 3 × 50 = 150 kw-hours each month, and 5 cents per kw-hour for all kw-hours over 150. This, as well as the discount system, has the disadvantage that the very short-hour customer still uses as much plant as the moderate or long-hour customer, and unless he should guarantee payment for one or two hours' use of his demand, pays you practically nothing for its use.

The third method, which seems best adapted to American practice, is to charge a fixed amount per year (payable in 12 equal installments, if desired) as rent for the investment. This is from $30 to $60 per kilowatt per year. Thus, if a customer's demand meter shows that some time during the previous year he used 4 kilowatts (80 lights), his charge for rent would be $240 per year (at $60 per kilowatt), or $20 a month. In addition a charge of 3 or 4 cents per kilowatt hour would cover the running expenses. Under this scheme, although each customer's bill would be enough to cover his share of the fixed expenses as well as his share of the running expenses, no customer would show profit enough to warrant the company's giving him a lower price except under very unusual circumstances.

These methods may be modified in whole or in detail to suit the circumstances of each company, and the particular prices would be different for each company. Thus, the running expenses per kilowatt will be far larger if coal is $5 a ton than if it is $1.50.

Special Advantages of the Wright System.—Every electric company has in its district many gas and oil users who burn their lights long hours, and cannot therefore afford to put in electricity at the present tariff. The Wright system gives a chance to offer to such a lower price at a good profit to the company. In addition it offers a lower price (at a greater profit to the company) to all customers who will use their lights longer hours, and that there are many such is well-known to any one who will notice how many houses there are where oil or gas is still used in dark corners where a constant light is required. Under a tariff which makes a very low charge for long hours the advantages of appearance and health will make electricity preferable.

The Wright system will discourage no customers except those who do not pay their proportion of the fixed charges, and who are, in fact, a loss to the company. If desirable, these customers may be retained under the old system, though it is usually better that they should be allowed to drop off, thus making room for really profitable customers.

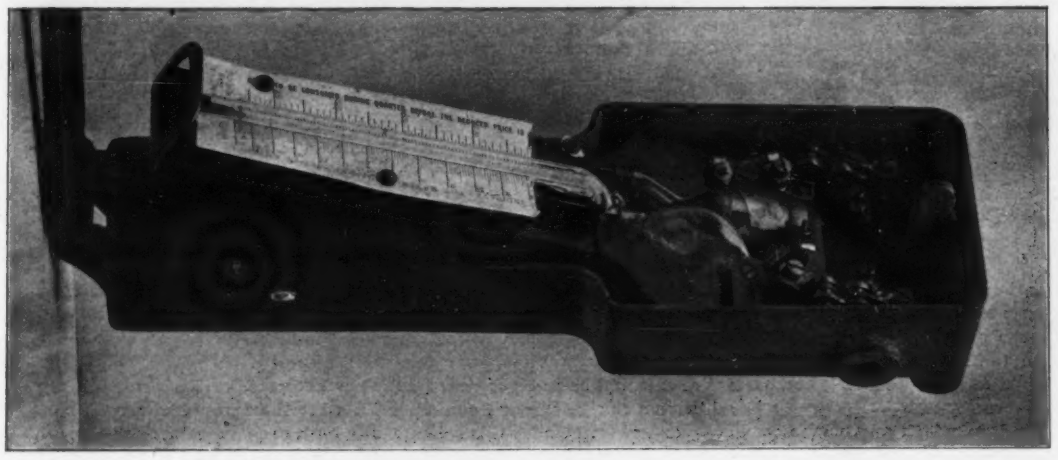
The Wright Demand Meter.—The meter to be used needs special consideration. It must show the maximum current used, it must be accurate, it must be such that it cannot be tampered with by the customer, it must be slow acting, it must not show a short circuit that acts only for the second (there is no part of the investment that will not stand an overload of 100 per cent. for a minute or two), and lastly, it must be impossible for it to get out of order, since the maximum that the meter records occurs only once in a year, and if the meter is out of order the opportunity is lost.

The Wright demand meter possesses all of these characteristics, and is simple as well as efficient. It consists of two sealed glass bulbs connected by a U-tube filled with a colored liquid. The current passes through a coil wrapped around the bulb, the heat expands the air therein and the air forces the liquid into the other bulb, out of which it is spilled into a closed tube. The greater the current the more liquid is forced up and spilled over. A scale is placed beside the closed tube, and may be calibrated so that the height of the liquid spilled over shows the current in amperes or in kilowatts or lamps at a given voltage. The reading may be returned to zero by tipping up the glass tube and allowing the liquid to flow back. No allowance need be made for external temperature, since that affects the air in both bulbs equally. The instrument can be calibrated as accurately as desired. It is furnished in a strong iron case that can be locked or sealed against tampering. It cannot get out of order since the only moving parts are the air and the liquid, and both are hermetically sealed in the glass bulbs and tubes. For the same reason it will never wear out. It will register slowly, approximately 90 per cent. in 5 minutes, 95 per cent. in 10 minutes, 99 per cent. in 15 minutes and 100 per cent. in 30 minutes, thus being fair to the customer. It will always register 100 per cent., in which (as well as in its reliability and freedom from getting out of order) it has the advantage over any mechanical form.

In conclusion it is enough to say that some 20 or 30 companies abroad are using the Wright system, and have no idea of going back to any other while hundreds of others are looking forward to adopting it. In

fact, it may be said that thousands of companies, both in the United States and abroad, have adopted it, since the only reason for selling current for power cheaper than for light is that power customers are long-hour customers.

The first company to adopt this system was the Brighton of England, three years ago and as a result of three years' use all of its 1300 customers are thoroughly satisfied with the system, and the company is to day selling 50 per cent. more current in proportion to the plant used than



Wright Demand Meter.

it could on the ordinary system of charging. That means that without reducing expenses it can reduce the average price to about 75 per cent. of the former price, keep up the same rate of dividends, and have everything over the 75 per cent. as clear profit. There is no reason why every company in the United States should not make a similar gain. The Chicago Edison, Boston Edison and New York Edison have already given trial orders for the meter.

Braking and Contact Methods on the Nantasket Beach Line.

On the line from Pemberton at the extreme end of Nantasket Beach to Nantasket Junction, on the Old Colony division of the New York, New Haven & Hartford system, a distance of 6.91 miles, the cars are operated by overhead trolley contact. From Nantasket Junction to East Weymouth the electricity is taken by means of the sliding contact shoes from a third rail laid in the centre of each track. When the cars start from the Junction station momentum is given to the car by electricity taken from the overhead wire, and it is carried over to the third rail. The trolley then slips from the termination of the overhead wire, is pulled down and hooked, and the shoes come into contact with the surface rail. A knife switch under the hood of the car being closed, the current from the rail is thrown into the motors and the operation of the train is continued without interruption.

One shoe is placed between the axle of each truck, immediately under

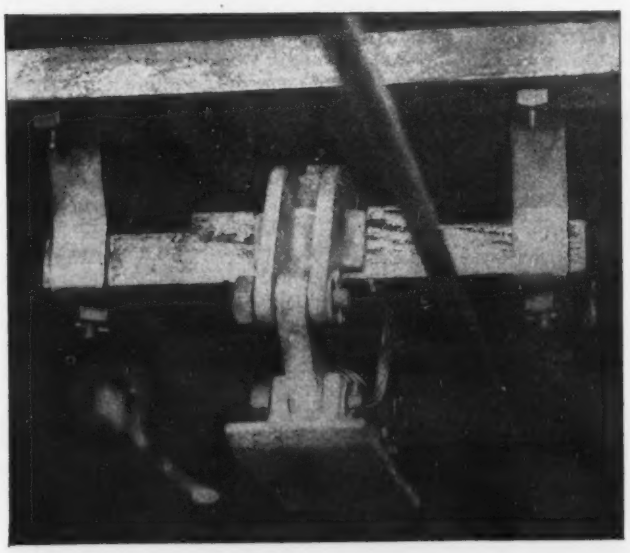


Fig. 1.—Contact Shoe for Third Rail.

the king pin. It is suspended by two links, and thus hangs loosely. This allows it to slide over the surface of the third rail without difficulty, and to make perfect and continuous contact. The distance between each of the shoes on a car is 33 feet; thus at crossings where no third rail is laid, less than 30 feet wide, one shoe is always in contact with the end of one section or the beginning of the next; at wider crossings the impetus of the moving car brings the shoes into contact again before the car can come to rest. Each shoe is a cast-iron plate 12 inches long and five inches wide. It weighs about 20 pounds, and is connected to the motor by a flexible cable.

The air for the brakes is supplied by an electrically-driven air compressor, automatically controlled by the air-pressure itself. The apparatus consists of a double-vertical air pump with single-acting cylinders 5¾ inches by 7 inches stroke, directly connected to a series-motor, the lower field of which is extended to form the base of the air pump. The connection between the two is thus rendered very rigid. The capacity of

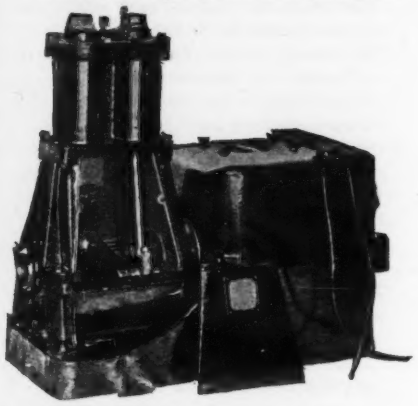


Fig. 2.—Air Compressor.

the pump is 52½ cubic feet of free air per minute, working against 90 pounds pressure per square inch. At this pressure the speed is 250 revolutions at 600 volts.

The air compressor is piped directly to the main reservoir, and is controlled automatically by a pneumatic governor consisting of a cylinder containing a piston working against a spring. The action of this automatic control is as follows: The pipe running from the main reservoir enters the cylinder below the piston. As the pressure rises the piston is forced upward against the spring. The other end of the piston-rod carries the contacts through which the pump motor circuit is made and broken. Any arcs that may be made when the contact is broken are

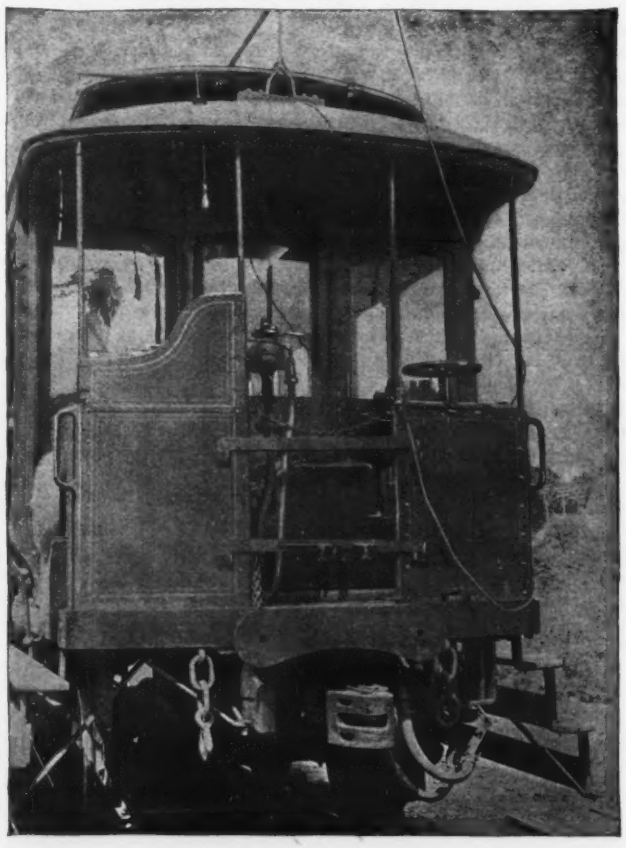


Fig. 3.—Platform of Car.

blown out in a magnetic field, the coils of which are connected directly in series with the motor.

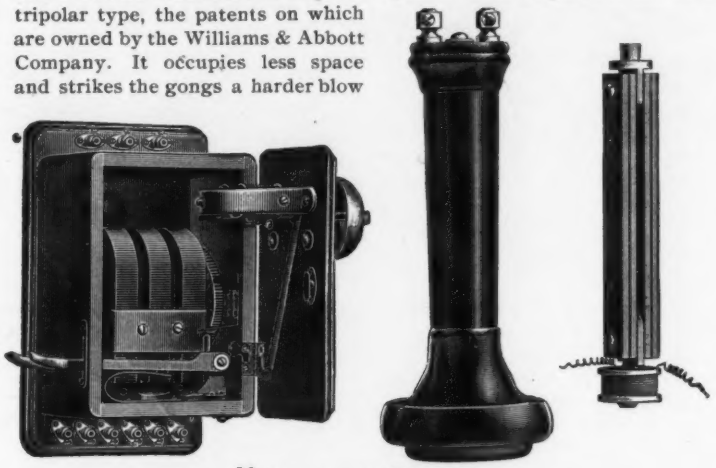
As the pressure in the reservoir falls from five to seven pounds, the piston is forced back into its normal position by the spring. The contacts are pushed down to their seat, the circuit is closed, current flows to the motor and the compressor starts. The circuit remains closed until

the pressure reaches normal, when it overcomes the force of the spring, forces the piston upward, separates the contact, breaks the circuit and the motor stops. This operation is repeated automatically, the combination of motor and pump requiring practically no attention. These automatic governors can be adjusted to any pressure from 45 to 100 pounds and work on a difference of from five to seven pounds in pressure.

The development of the combined air pump, motor and automatic governor is due to the General Electric Company. It is of recent design and takes the place of the oscillating-cylinder type of air pump with which the motor cars were originally equipped.

Telephone Magnetos and Receivers.

The accompanying illustrations represent forms of magnetic bells and receivers manufactured by the Williams & Abbott Electric Company, 9 and 11 Huron Street, Cleveland, O. The exchange bell is fitted with a reliable form of automatic hook, and the binding posts are attached to separate bases, to prevent turning. All of the wiring is placed in grooves at the back of the box, and all connections are made permanent, so as to avoid trouble with loose or imperfect joints. The ringer is of the new tripolar type, the patents on which are owned by the Williams & Abbott Company. It occupies less space and strikes the gongs a harder blow than is possible with the ordinary type of magneto. The mechanical work of these devices is first-class in every way. The generator has extra long bearings and a groove in which pass cast cut gears, and its operation is almost noiseless.

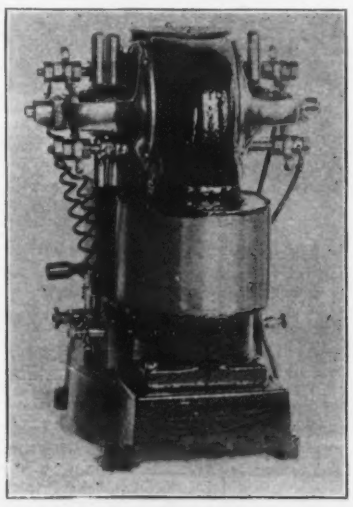


MAGNETO AND RECEIVER.

The receivers consist of hard rubber shells and four-bar compound magnets, the spool being wound to 75 ohms with silk-covered wire. The permanent magnets are composed of a special grade of magnet steel, and are guaranteed against loss of magnetism.

A Small Motor Generator.

The accompanying illustration shows a motor generator especially designed for use on telephone call circuits. It transforms a continuous current of 110 volts into an alternating current of 100 volts. The motor terminals are directly connected to lighting mains of 110 volts, and an alternating current of 75 volts is collected from the sliding rings on the generator side. The alternating current is then led into the primary winding of a static transformer (located in the hollow base of the machine), in which the potential is raised to 100 volts. The coils of the telephone bells have therefore no electric connection with the lighting mains, an advantage which every telephone man will appreciate.



MOTOR GENERATOR.

The armature is wound with but a single winding of double silk-covered wire, ensuring cool running and perfect insulation. In a test the secondary of the transformer was short-circuited for several hours without affecting, it is stated, the operation of the machine in any manner. The speed is 1000 revolutions per minute, giving a frequency conforming to the requirements of telephone service. Carbon brushes are used on both commutator and collector rings.

The mechanical construction is of the best and the machine will withstand the wear and tear of constant running. The bearings are self-oiling, and one oiling will last for several weeks.

It is stated that this machine has replaced all the magneto-generators in some of the large office buildings in Chicago.

It is claimed that the first cost of the motor generator is much less than that of the magnetos which it can replace and it is much easier to keep in repair than a large number of magnetos. Telephone subscribers also find it much more convenient to push a button than to turn the crank in making calls.

This machine is built by Roth Bros. & Company, 30-34 Market Street, Chicago. A number of them have been supplied to the Chicago Telephone Company, and are said to be giving good satisfaction. They are also wound for other voltages. Machines of this description are also applicable to medical practice.

Among the St. Louis Exhibitors.

The General Electric Company will be represented at the St. Louis Convention by an exhibit which will embrace the newest developments in the electric traction field. So far as at present arranged the exhibit will comprise examples of the standard apparatus of the company's manufacture as well as the latest devices developed since the last convention.

A General Electric 1000 motor equipment will be mounted on a truck and will be shown in operation with the electric brake. One of the Brooklyn Bridge car trucks will be exhibited equipped with two General Electric 2000 motors and near by examples of the General Electric 800, 1000, 12,000 and General Electric 51 types of motors. The controller section will include examples of the K10, B6 and L2 controllers, as well as one of those used to handle the great 96-ton electric locomotives of the Baltimore & Ohio Railroad. A switchboard made up of generator and feeder panels with full equipment of standard instruments, rheostats, etc., will be installed. Lightning arresters will be shown in operation, and the magnetic blowout device and the working of the principle will be fully explained. The General Electric Company will be represented by W. J. Clark, A. D. Page, R. H. Beach and T. Beran, New York; J. R. Lovejoy, W. B. Potter, L. H. Parker and H. C. Wirt, Schenectady; F. M. Kimball and C. C. Pierce, Boston; B. E. Sunny, Theo. P. Bailey, G. K. Wheeler, F. N. Boyer and E. C. Noe, Chicago; E. D. Mullen and H. J. Crowley, Philadelphia; W. F. Hays and F. H. Strieby, Cincinnati; G. D. Rosenthal, St. Louis.

Chloride of Silver Test Battery.

The Chloride of Silver Dry Cell Battery Company of Baltimore, Md., manufactures a chloride of silver test battery which is said to be very extensively used and well known. The batteries have been in service under many varieties of conditions for the past 10 years and are said to have given entire satisfaction. The chief claims for them are that they are constant, they will not dry out, and have long life and an absence of local action.

CHLORIDE OF SILVER BATTERY.

The battery is provided with a pole-changing switch attached to the inside of the box cover and selecting chords and tips, by which the convenience and adaptability of the battery is made all that can be desired. The outside dimensions of a battery of 50 cells are 6 x 7 x 10 inches, the weight being about 10 pounds. The cells are contained in a handsomely finished box of mahogany.

NEWS OF THE WEEK

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

NEW YORK, Oct. 17, 1896.

ELECTRICAL STOCKS during the first four days of the week have showed a general improvement in prices.

TELEGRAPH AND TELEPHONES generally have experienced general advances in prices, the exceptions being the telephone stocks, which are slightly lower than our last previous quotations.

TRACTIONS show a general improvement in prices.

FINANCIAL STATEMENT.—The statement of the financial operations of the Edison Electric Illuminating Company of New York, for the month of September and for the nine months ending September, show the following results: Gross receipts September, $163,993.68, an increase of $15,688.47 over September last year; net receipts, $71,592.81, an increase of $8,505.50. For the nine months' period, gross receipts, $1,581,806.55, an increase of $147,585.51 over the same period last year; net receipts, $747,775.67, an increase of $80,410.35.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked
Chicago Edison Company	100	..	..
Edison Electric Ill., New York	100	93½	95
" " " Brooklyn	100	88	93
" " " Boston	100	..	..
" " " Philadelphia	100	..	..
Edison Ore Milling	100	7½	10
Electric Storage Co., Philadelphia	100	27½	27½
Electric Storage, pref	100	29⅞	30
General Electric	100	26	27
General Electric, pref	100	64	67
Westinghouse Consolidated, com	50	23	24
" " pref	50	49	50
BONDS.			
Edison Electric Ill., New York	105	..	106½
Edison Electric Light of Europe	100	75	85
General Electric Co., deb. 5s	100	88½	..
TELEGRAPH AND TELEPHONE.			
American Bell Telephone	100	202	202½
American District Telegraph	100	*29	39
American Telegraph & Cable	100	..	91
Central & South American Telegraph	100	124	127
Commercial Cables	100	140	..
Erie Telephone	100	58¾	60
New England Telephone	100	94	..
Postal Telegraph-Cable	100	78	80
Western Union Telegraph	100	82⅝	82⅞
ELECTRIC TRACTION STOCKS.			
Baltimore Traction	25	16⅞	17
Brooklyn Rapid Transit		19¾	20
Brooklyn Traction	100	..	14
" " pref	100	46	48
Buffalo St. Ry	100	66	68
Cleveland Electric Ry	100	..	..
Columbus St. Ry	100	40	42
Hestonville	100	48	48½
" pref		..	62½
New Orleans Traction	100	5	7
" " pref	100	..	35
North Shore Traction	100	20	23
" " pref	100	70	73
Rochester St. Ry	..	15	20
Steinway Ry	..	45	50
Union Railway (Huckleberry)		98	103
Union Traction, rcts $10 pd	..	12¾	13
West End, Boston	100	67	..
" " pref	100	90	..
Worcester Traction	100	15	18
" " pref	100	85	88
BONDS.			
Brooklyn Rapid Transit 5s, 1945	100	73	..
Buffalo St. Ry. 1st con. 5s	100	..	*104
Cleveland Elec. Ry. 1st mtge 5s	100	100	*103
*Columbus St. Ry. 1st 5s	100	90	*95
Rochester St. Ry. 1st 5s	100	..	98
Union Railway (Huckleberry) 1st mtge 5s		100	*103
*Westchester Electric 1st mtge 5s	100	100	103

* With accrued interest.

PROPOSED CONSOLIDATION.—The San Francisco Gas Light Company will hold a stockholders' meeting Oct. 26, to consider and act upon the proposition to diminish the capital stock from $10,000,000, at $100 a share, to $300,000, divided into 100,000 shares of the par value of $3 each. The special meeting is a part of the plan to consolidate the above company with the Edison Light & Power Company, of this city. According to the notice issued to the stockholders, the new company to be formed from the other two companies is to be called the San Francisco Gas & Electric Company, capital stock $20,000,000, of which $10,900,000 will be issued to the stockholders of the San Francisco Gas Light Company, $2,750,000 to the stockholders of the Edison Light & Power Company, and $1,066,666.67 to be placed in escrow for the purpose of redeeming the outstanding bonds of the Edison Light & Power Company. All the remainder of the stock is to be held in the hands of the company and will not be issued unless necessity requires the same for the enlargement, extension or improvement of the plant.

Special Correspondence.

NEW YORK NOTES.

Office of THE ELECTRICAL WORLD,
253 Broadway, NEW YORK, Oct. 26, 1896.

THE PHILLIPS INSULATED WIRE CO. has given up its New York office and all business in future will be conducted direct from the general office and factory at Pawtucket, R. I. The officers of the company are: H. C. Adams, president; H. O. Phillips, treasurer and general manager, and H. C. Adams, Jr., secretary.

FROM THE BROOKLYN BRIDGE TO FLUSHING.—The Brooklyn Heights Railway Company has about completed its plans to start work on its Flushing branch, which will provide a route from the Brooklyn Bridge direct to Flushing. As a consideration for the franchise for this line the railway company agreed to contribute $2000 toward the building of the new bridge across the creek between Corona and Flushing and to light the structure and keep it in repair.

STOPPING CARS ON CROSSINGS.—The Brooklyn ordinance referring to the stopping of trolley cars at street crossings so as to bring the fenders in line with the first crossing has been amended with the effect of reversing the the rule. In future the cars will not be stopped until the street is crossed, so that the rear end of the car will be in line with the further crossing. There was a strong popular sentiment against the old rule, and the substitution of the new will be hailed with satisfaction by Brooklyn people.

TROLLEY CARS AND BIKES TOO NOISY.—A combination of trolley car and bicycle bell noises has caused the Rev. Dr. R. Marshall Harrison to resign the pastorate of the Brooklyn Heights Baptist Church on Bedford Avenue and Bergen Street. Dr. Harrison complains that he is unable to properly conduct the services and was seriously hampered in his work, owing to the noise and din caused by the trolley cars on Bergen Street and the almost constant procession of wheelmen and horsemen on Bedford Avenue, on the corner of which streets the church is located.

BROOKLYN'S SUBWAY COMMISSIONERS.—On Nov. 1 next Messrs. George W. Plympton and Frederick R. Lee will cease to be commissioners of electrical subways in Brooklyn. The Act of 1892, under which they were appointed, limits their term of office to Nov. 1, at which time their duties are to be transferred to the Mayor and the Commissioner of City Works. Several bills were introduced at the last session of the Legislature providing for the appointment of a commissioner by the Mayor, but none of them passed. All of the expenses of the Board are paid by the telegraph and telephone companies.

IRON ELECTRIC LIGHT POLES.—At a meeting of the Gas Commission on Oct. 10 a proposition was presented having for its object the substitution of iron poles for wooden poles now used by electric light companies. The representatives of the companies entered a protest on the ground that iron poles, which are said to be patented, would cost from 50 to 100 per cent. more than the wooden poles, and as there are 3000 poles in the city, the change would entail an outlay of $250,000. There was a question as to who had authority to say what sort of poles should be used, the Board of Electrical Control or the Board of Public Works. The matter was referred to Corporation-Counsel Scott and will be taken up again next Wednesday.

BUFFALO AND WESTERN NEW YORK NOTES.

BUFFALO, N. Y., Oct. 14, 1896.

POWER FRANCHISE TRANSFER SANCTIONED.—The Buffalo Aldermen have sanctioned the transfer of the power franchise from the Niagara Falls Power Company to the Cataract Power & Conduit Company.

NIAGARA FALLS POWER FOR STREET RAILWAYS.—It is expected that by November the Niagara Street power-house of the Buffalo Railway Company will be supplied with power from Niagara Falls. All the poles for the transmission-wires are in position, and the material for the erection of the terminal station at the foot of Bruce Street is laid down at the spot.

CANADIAN MATHER-POWER BRIDGE BILL PASSED.—The bill incorporating the Mather & Power Company, with power to erect a traffic bridge between Buffalo and Fort Erie, and to place wheels for the generation of electric energy between the piers, passed the Canadian House of Commons after the following clause had been inserted in the bill: "The privileges hereby conferred, and the lawful use and enjoyment thereof, shall always be subject to such conditions as the Governor in council may from time to time impose, including, among others, the payment of an annual rental or percentage of gross receipts for such privileges." It is the intention to insert this clause hereafter in all similar bills.

TONAWANDA POWER CELEBRATION.—Tonawanda is to have a celebration of the advent of Niagara Falls power. No definite arrangements have yet been made for the celebration, but the Village Board will take up the matter and see that the event is fittingly commemorated. President Vandervoort is one of the chief promoters of the scheme, and will endeavor to have the celebration ceremonies of an imposing and appropriate character. Of course no date has yet been fixed for the event, but it is being considered by the Board of Trustees and leading citizens, and details will shortly be arranged. The advent of the power will, it is expected, be a great day in the history of the twin cities. The people of the Tonawandas believe that there is a great industrial future in store for this city, and they are consequently gratified at the extraordinary concessions secured by the Village Board for the delivery of all the electric power required at present or to be required in the future by the manufacturing industries of the Twin Cities.

CONTRACT SIGNED.—The Niagara Falls Power Company and the North Tonawanda officials have just signed the power franchise. The contract was granted without many changes from the original, but the few alterations made were of vast importance. The franchise as first drafted contained a clause stating that North Tonawanda should pay the same price for power as would be paid by Buffalo. After a good deal of work the officials induced the company to come down 7½ per cent. in the price for power at Buffalo. The only other change made in the contract was the additional clause, which reads as follows: "In the event of any dispute in respect to the prices to be charged for power under the provisions of the fourth clause hereof, it is agreed that the president of the village of North Tonawanda, or his successor, shall have such access to the books and papers of the company furnishing power under the franchise granted by the City of Buffalo to the Niagara Falls Power Company, and hereinbefore referred to, as will enable him to ascertain the prices charged for like amounts of similar power for similar uses in the City of Buffalo.'

BUFFALO ELECTRIC POWER CELEBRATION.—A second meeting to discuss the proposed power celebration was held at the committee room of the Merchants' Exchange. The subject was very thoroughly discussed. Presi- R. R. Hefford of the Merchants' Exchange presided. Others present were S. S. Kingsley and F. S. Oakes, of the Real Estate Exchange; F. L. Danforth and Pascal P. Pratt, of the Bankers' Association; N. W. Ransom and B. Williams, of the Live Stock Exchange; H. H. Littell, of the Buffalo Railway Company; Alfred Lyth, of the Builders' Exchange; Charles R. Huntley, of the Buffalo General Electric Company; Richard Humphrey, of the Black Rock Business Men's Association; Rufus M. Choate and W. H. Newerf, of the South Buffalo Business Men's Association; H. A. Foster, consulting engineer of the Niagara Falls Power Company, and Frank C. Perkins, electrical engineer. Mr. Huntley was asked for some practical information. He said that the 1000 horse-power that will be delivered in Buffalo next month would run about 10,000 ordinary electric lights. Mr. Littell made a generous offer on behalf of the Buffalo Railway Company. He said that his company would give 1000 horse-power for the use of a demonstration such as is contemplated. "I think," said Mr. Littell, "that we should get together and congratulate ourselves on the accomplishment of what we have been looking forward to for years." Mr. Littell said that if it appeared practical next year it would be a good idea to have an exposition. It was some time since the World's Fair and he thought a great many exhibitors would be glad to come to Buffalo. "The time is now ripe," he said, "for another exposition of electrical supplies." There was a general expression of approval of the views expressed by Mr. Littell. Mr. Huntley said that Niagara Square was a better place for the illumination than Lafayette Park, because it is easier of access. He added that there would not be enough power at the disposal of the projectors to make a general illumination a success this season. He thought it would be a better plan to wait a while before taking any steps regarding the exposition next season. Mr. Huntley suggested that nothing be done in the way of arranging for a demonstration for an earlier date than Dec. 15. He said that the power would be here about Nov. 15, and that a period of 30 days should be allowed for experiments. The entire subject matter was finally laid upon the table until the next meeting, and a committtee consisting of Messrs. Huntley, Kingsley and Hefford appointed to act in conjunction with the committees appointed by the Mayor

NEW ENGLAND NOTES.

Branch Office of THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, MASS., Oct. 14, 1896.

THE CONSOLIDATED INSULATED TUBE COMPANY, Boston, has purchased all the rights, title and interest, together with machinery and patents, of the Builders' Insulated Tube Company, Lynn, Mass., and of the Kinney Electric Conduit Company, Boston, Mass., and will manufacture a full line of plain and armored tubing for interior and underground electrical wiring.

STREET RAILWAY CONVENTION.—From 25 to 30 electric railway officials of Massachusetts, and possibly more, will leave Boston on a special car from the Park Square Station, New York, New Haven & Hartford Railway, at 7 p. m., Saturday, Oct. 17, and run *via* New York, Philadelphia and Washington, and the Chesapeake & Ohio Railway to Cincinnati and Indianapolis, and the Big Four to St. Louis, arriving at St. Louis at 6.56 p. m. Monday. The delegation will, as usual, be in charge of Mr. Charles S. Clark, secretary of the Massachusetts Street Railway Association. This party will by no means represent the full attendance from Massachusetts, as quite a number will go by other routes

THE GLOBE ELECTRIC LIGHT COMPANY, manufacturers of "Globe ncandescent lamps, is now located in a nice factory at Malden, Mass., and is already quite busy filling orders. It is useless to disguise the fact that this company has been somewhat unfortunate in getting into business shape, but the change for the better has at last come about, and the company is now ready to do business on a business basis, its officers and directors comprising reliable business men of Boston. It is manufacturing lamps, and all orders will be filled with promptness. The company claims for its lamp manufactures the highest efficiency, life, and maintenance of candle-power. Mr. Reinold Berrenberg and his brother, Mr. Albert Berrenberg, are well known in incande cent lamp manufacture, and particularly as inventors of a vacuum pump

WESTERN NOTES.

Branch Office of THE ELECTRICAL WORLD,
936 Monadnock Building,
CHICAGO, ILL., Oct. 14, 1896.

TO CONTINUE BUSINESS FOR THREE MONTHS.—Receiver D. M Sloan, of the Ohio Electric Company, Pittsburg, Pa., has been ordered by the court to continue the operation of the works for the next three months.

THE STROMBERG CARLSON TELEPHONE MANUFACTURING COM PANY, Chicago, has outgrown its quarters in the Springer Building and will move to more commodious quarters in the large new building corner of Jackson Boulevard and Clinton Street, where it will have more machinery and floor space. The policy of this company has been to quietly produce and sell its apparatus at its own prices regardless of competition. The fact that its business is thus increasing argues well for the excellent quality of its product and the favor with which it is received.

DEPARTMENT OF ELECTRICITY.—An ordinance has been presented to the Chicago City Council providing for the establishment of a department of electricity, which shall be separate and distinct from the fire department. The present electrical department is a bureau of the fire department and subordinate thereto, and in case the new proposition is carried John P. Barrett will become a member of the official board, with higher power and privileges than he has heretofore possessed. There is every indication that the proposed ordinance will be passed, and Mayor Swift and Commissioner Downey are in favor of the separation of the electrical department from the fire department.

THE MISSOURI TELEPHONE MANUFACTURING COMPANY, 917-919 Market Street, St. Louis, extends a cordial invitation to all street railway men and others in attendance at the convention to call and inspect its factory. Its establishment is situated in close proximity to the Auditorium, where the convention will be held, and there will be found a street railway phone which will have special interest for street railway men. The Missouri Telephone Manufacturing Company is compelled to work its force and factory day and night in order to meet the increasing demand for its instruments and it states that large orders for the same are being constantly received. The company now manufactures its own woodwork and all the parts of its instruments in its own factory. All visitors to the factory will be presented with a souvenir of the occasion

General News.

NEW INCORPORATIONS.

THE BRYAN ICE, LIGHT & POWER COMPANY, Bryan, Tex., has been formed by J. N. Cole, W. E. Sanders, G. W. Smith, Bryan, Tex., and L. T. Fuller, Calvert, Texas. Capital stock, $20,000.

THE AKRON LIGHT, FUEL & POWER COMPANY, Akron, N. Y., has been formed by J. W Sterans, I. D. Eckerson, R H. Bell, Akron, N. Y. and J. H. Campbell, Butler, Pa. Capital stock, $10,000.

THE WORCESTER & CLINTON STREET RAILWAY COMPANY, Worcester, Mass., has been formed, with a capital stock of $150,000, by Charles E. Dresser, Charles E. Hudson, W. S. Reed and H. L. Pierce.

THE FERGUS FALLS WATER-WORKS COMPANY, Portland, Me., has been incorporated with a capital stock of $60,000. The incorporators are James C. Fox, Robert T. Whitehead and Harry M. Verrill, Portland, Me.

THE INTERNATIONAL UNDERGROUND ELECTRIC COMPANY, Camden, N. J., has been formed by Simon J. Martin, Ellery P. Ingham, Frank Battles, Frank S. Hansell and Herman Rosade. Capital stock, $250,000.

THE CLEVELAND & SOUTHEASTERN ELECTRIC COMPANY, Cleveland, O., has been incorporated with a capital stock of $10,000. The incorporators are Harry C. Mason, Frederick L. Taft, A. M. Austin, Alfred P. Biddle and C. H. Olds.

THE SALT LAKE ELECTRIC SUPPLY COMPANY, Salt Lake City Utah, has been incorporated with a capital stock of $20,000. The directors of the company are R. W Nichol, president; E. Mill, vice-president, and S. J. Weisel, secretary and treasurer.

TELEGRAPH AND TELEPHONE.

LOUISVILLE, KY.—The East Tennessee Telephone Company's line to Fulton is about completed.

GADSEN, ALA.—The telephone line from this place to Walnut Grove is rapidly approaching completion.

BROWNSTOWN, IND.—A telephone line is to be constructed from this place to Seymour and other places in this vicinity.

BROCKTON, ILL.—A company has been formed in this place to build a telephone line from here to Oakland. Work will begin immediately.

MOLINE, ILL.—This city is connected with the long-distance telephone system, and it is now possible to talk with New York and other cities connected with the lines.

DES MOINES, IA.—The Mutual Telephone Company has completed arrangements to commence work on its new exchange in this place. It will start out with 800 subscribers.

ERIE TELEGRAPH & TELEPHONE COMPANY made a net gain of 300 subscribers in September, 758 for the three months ending Sept. 30 and 2123 for the nine months of 1896. Total number connected Sept. 30, 20,714

KEOKUK, IA.—The Western Illinois Telephone Company has asked the City Council for permission to build its line in certain streets in order to effect an entrance to this city.

BLOOMINGTON, WIS.—The Grant County Telephone Company is extending its line to Plattville on the top of the new electric light poles. The line will also be extended to Beetown and Cassville.

MILWAUKEE, WIS.—The American Telephone & Telegraph Company contemplates the building of a long-distance line from Minneapolis to Chicago, which will pass through several cities in this State. It has been practically decided to run the line through Madison.

ST. JOSEPH, MO.—The Missouri & Kansas Telephone Company is now engaged in laying its cables in the conduits which were constructed a year or more ago. The work is being conducted under the supervision of Mr. S. Fraser, of Chicago, who is an expert in this particular line.

Electric Light and Power.

PARKER, S. D.—The prospect is good for the establishing of an electric light plant in this place.

OKALONA, MISS.—The citizens have voted to issue $30,000 in bonds to put in a water and light plant.

LODI, WIS.—The city fathers accepted Thomas Hackle's offer and decided to give him a 10 years' franchise to put in an electric light plant.

HAMILTON, O.—The gas trustees have accepted the city electric light plant, which was turned over to them by the City Council on Sept. 15.

PHILADELPHIA, PA.—Bills have been introduced in Councils to appropriate $25,000 for the erection of an electric light plant in Fairmount Park.

PEORIA, ILL.—The Peoria General Electric Company has just installed a new 1000-hp engine at its power-house. The improvement will give an additional capacity of 20,000 incandescent lamps.

MADISON, WIS.—It is likely that a franchise for a new electric light company will be sought at the next meeting of the City Council and the indications are that it will be secured. The municipal electric-lighting idea does not meet with much favor among the Aldermen.

AUSTIN, ILL.—The Cicero, Heat, Light & Power Company, which supplies Austin with electric light, submitted a proposition to the Town Board to sell its plant to the town. The price was not made public, but it is said that the town could save several thousand dollars yearly by purchasing the plant.

JAMAICA, L. I., N. Y.—The Jamaica Electric Light Company has commenced the erection of a new power station on Van Wyck Avenue. The plant will include three 125-hp boilers and three 120-hp engines and a new 2000-incandescent light machine. The new plant will be in operation by Dec. 1.

PAWTUCKET, R. I.—At a recent meeting of the special committee on the municipal electric light plant project, it was voted to postpone action until after the municipal election, for the reason that any steps which might be taken at this time might be misunderstood as being taken for political effect.

BEATRICE, NEB.—It is reported that a new electric light company has been formed in this city, that a franchise will be asked for at the next meeting of the Council, and that immediately upon the granting of the same work will begin upon the new plant. The organizers have ample funds to carry out the project.

MARQUETTE, MICH.—The temporary injunction enjoining the Negaunee City Council from establishing a municipal electric lighting plant without submitting the proposition to the taxpayers has been made permanent. The decision is causing the Aldermen some embarrassment, as they had already made contracts for work and material aggregating $10,000.

The Electric Railway.

NEW ORLEANS, LA.—J. P. Maury, president of the New Orleans Traction Company, is arranging to secure money to build a new power-house.

YONKERS, N. Y.—The Board of Health of this city has ordered the trolley company to discontinue the use of open cars on account of the cold weather.

WEST CHESTER, N. Y.—The Mount Vernon Common Council has consented to the extension of the trolley railway from South Fifth Avenue to Boston Post Road

ATLANTIC HIGHLANDS, N. J.—The Atlantic Highlands, Red Bank & Long Branch Electric Railway Company is endeavoring to get a right of way from Eatontown through Oakhurst, Elberon and Deal Beach to Asbury Park.

SYRACUSE, N. Y.—C. Sidney Shepherd has been appointed receiver for the Lake Ontario & Electric Street Railroad. The Walker Company, of Cleveland, held a chattel mortgage of $1300. Various claims were included in the sheriff's levy.

BEAVER FALLS, PA.—The Riverview Electric Railway Company, organized two years ago to build a line from here to Beaver, *via* Patterson's Heights, has again taken up the project and it is likely that the line will be built, probably this Fall.

FAIRPORT, O.—The citizens of this place are endeavoring to induce the directors of the Cleveland, Zanesville & Eastern Electric Railway to extend the line to this place. It is understood that a favorable financial proposition will be submitted to the railway company.

NYACK, N. Y.—It is said that the Palisade Trolley Company, which expects to extend its line to Sparkill, is making inquiries of some property owners in and near Grand View to see if it is possible to obtain the right of way to Nyack for the purpose of extending the trolley up to this point.

BRIDGEPORT, CONN.—It is reported that the New York, New Haven & Hartford Railroad Company has absorbed the Bridgeport Traction Company. The report, however, is denied by the fiscal agents of the former, but in certain quarters it is believed that there is some truth in it.

Trade and Industrial Notes.

THE KESTER ELECTRIC MANUFACTURING COMPANY, Buffalo, N. Y., informs us that it has purchased from the Buffalo Seal & Press Company all of the rights, titles and interest in the Victor bicycle lamp and tapers, and will hereafter continue the manufacture of the same.

THE STOREY MOTOR & TOOL COMPANY has moved its main office and factory to 214–226 Carter Street, Philadelphia, where with greatly increased facilities, made necessary by the rapid growth of its business, it will be able to promptly execute orders of any size that you may place with it.

THE LYNN INCANDESCENT LAMP COMPANY, Lynn, Mass., judges from the number of orders it is receiving that its business is evidently becoming popular. The company has renewed 400,000 incandescent lamps by its own process. Renewed lamps are guaranteed to be equal in appearance to the original. It is claimed that lamps bills can be reduced one quarter by having burned out lamps renewed by this company's process.

REPLOGLE GOVERNOR.—This water-power governer is guaranteed by its makers, the Replogle Gouernor Works, Akron, O., to govern water-power, under proper conditions, within limits usually attained by the best Corliss engine practice. Special attention is given by the Replogle Company to electric railway, electric light and power requirements, and this wheel seems to be giving satisfactory service wherever it has been installed.

THE PERU ELECTRIC MANUFACTURING COMPANY, Peru, Ind., is manufacturing a main line fuse box for which is claimed compactness and simplicity of wiring. The design is such that it can be built in sizes from four circuits up to 100, and it is claimed to be in every way a very serviceable and reliable device. Regarding the company's batteries, it is reported that its "Peru," Laclede and Hercules types are giving great satisfaction to those who are using them. The carbon being of a fine quality promotes efficient action of the batteries. The company's porcelain insulation is also meeting with considerable favor in the trade.

J. JONES & SONS, manufacturers and dealers in general electrical supplies, 67 Cortlandt Street, New York, are up to the times as usual and have just issued a complete electric light catalogue. The work bears evidence of great care having been bestowed upon its production. The firm will shortly issue a companion catalogue listing its electric bell, gas lighting, telegraph, telephone and house supplies complete. This firm enjoys the patronage of almost all the large electrical concerns in the United States, and it may be especially noted that they are manufacturers. This enterprising house is doing a large trade.

THE ZIEGLER ELECTRIC COMPANY, Boston, Mass., has just issued its catalogue, No. 53, which is a very complete production of its kind. It illustrates very profusely the various kinds of apparatus manufactured and handled by this well-known company, and a very handy index is provided at the back. The illustrations are of a high class and are well executed. The company has largely increased its stock and facilities, and has abandoned many obsolete appliances and improved the forms retained. This house is well known in the trade, and furnishes the best and most reliable class of material, and those who are interested in this line will do well to communicate with the Ziegler Electric Company before placing their orders.

ALBANY GREASE.—The managers of electric street railways will do well and probably profit by looking into the merits of the compound known in the trade as Albany grease. It is used for motor journals and is said to avoid burning out of armatures or brasses, which is of frequent occurrence when mineral greases are used. The Albany lubricating compound is recommended by a prominent electrical concern as being the purest and best artiele for use on dynamos. It is claimed to be available at any temperature, saves burning out of armatures, saves repairs and gives the best lubrication. This compound is manufactured by the Albany Lubricating Compound & Cup Company, Adam Cook's Sons, proprietors, 313 West Street, New York City.

PORTABLE TELEPHONE SET.—The Viaduct Manufacturing Company, Baltimore, Md., is constantly at work getting out new devices in the telephone and electrical line to give the public all conveniences possible. The latest is a little portable telephone set, which will be useful in many ways, but particularly where a person is likely to be called up at night, and is especially valuable for doctors, trainmen, inspectors, etc. By placing this little instrument on a chair by their bedside they can answer a call without getting out of bed. Much time could be saved by the use of these instruments on trains and trolley cars, and telephone inspectors, by carrying one of these sets along, would have a complete outfit with them, instead of a mere receiver or magneto bell.

K. McLENNAN & CO., Chicago, sole manufacturers of Gale's commutator compound, are meeting with an excellent business, and the satisfaction with which the compound has met has exceeded their most sanguine expectations. It is stated that the Fort Wayne Electric Corporation recently made a careful and exhaustive test of the compound, and reports that it was attended with very satisfactory results. The Fort Wayne Company recommends it to those having trouble with sparking of the commutator, etc. When applied, the commutator assumes a hard gloss. Mr. Isaacs will represent the firm at the St. Louis convention, and will have with him a large supply of samples so that every delegate may make a personal test and judge for himself of the merits of the compound.

THE BERLIN IRON BRIDGE COMPANY, East Berlin, Conn., notwithstanding the general distress among manufacturing concerns, reports that its plant is fairly well employed. At no time during the year has it run on short hours. It has contracts on hand to keep the plant employed on full time for the next two months. Some of these may be mentioned as follows: Power-station for the electrical equipment of the N. Y., N. H. & H. R. R. at Stamford, Conn., and a new building for the Woonsocket Electric Machine & Power Company, Woonsocket, R. I. The Berlin Iron Bridge Company has received from its representative at Lerdo, Mex., the contract for an iron market house at Guadalajara.

PERSONAL NOTES.

MR. JOHN LANDIS, superintendent of the American Lighting & Reflector Company, Chicago, is receiving the congratulations of his many friends on the twenty-fifth anniversary of his wedding.

MR H. C ADAMS, JR., has been promoted to the position of secretary of the Phillips Insulated Wire Company, and will hereafter make his headquarters at Pawtucket, R. I. The New York office of the company, of which Mr. Adams was manager, will be closed. Mr. Adams will have charge of the sales department, and will visit the trade as heretofore.

EX-GOV. FULLER, of Vermont, who died at his home in Brattleboro, Vt., on Oct. 10, was during his earlier career connected with electrical interests. At the age of 13 years he studied telegraphy and the art of printing. He afterward went to Boston, where he served an apprenticeship as a machinist, taking a course of scientific study in the evening schools, and for a time worked as night operator in the Merchants' Exchange. Gov. Fuller was one of the leading citizens of Brattleboro and was prominently identified with various public and private enterprises, standing high in the estimation of the community.

Business Notices.

THE ILLUSTRATIONS in this issue were made by the Photo-Engraving Company, 67-71 Park Place, New York.

BATTERY CUT-OUT CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, 105 South Warren Street, Syracuse, N. Y.

Illustrated Record of Electrical Patents.

UNITED STATES PATENTS ISSUED OCT. 13, 1896.

[In charge of Wm. A. Rosenbaum, 177 Times Building, New York.]

569,246. BLOCK SIGNAL; L. C. Smith. Carbondale, Pa. App. filed July 9r 1895. In a block signal system, a signal and means for setting the same to "danger," a series of locking devices operated simultaneously to lock said signal in "danger" position upon the passage of a train, and means fo, unlocking said devices successively.

569,262. ELECTROMAGNET; J. Wayland, Newark, N. J. App. filed Dec. 10. 1895. An electromagnet provided with a straight core having a polar extension at each end, a curved armature at each end embracing the lateral and end faces of each pole piece, and having an end face for engaging the top of the polar extension, the armature being journaled to rock in a plane transverse to the core.

569,263. RAILWAY SIGNAL; J. Wayland, Newark, N. J. App. filed April 14, 1896. A railway signal comprising a magnetic signal-operating device controlled by the presence of a train, a circuit-breaker operated thereby for opening the circuit when the signal is operated, an auxiliary tubular magnet through which the signal rod passes, said magnet being in a shunt of high resistance around the magnetic signaling operating device and the circuit-breaker, an armature carried by said rod, and connections for energizing the tubular magnet when the signal is operated.

569,265. RAILWAY SIGNAL; J. Wayland, Newark, N. J. App. filed June 2, 1896. A railway signal comprising a semaphore controlled by two magnets having their axis in the same line, one of low resistance to operate the signal and the other of high resistance to lock the same, a circuit-changer operated by the signal apparatus for controlling the circuit of the low resistance magnet, and a shunt around the circuit-changer and low-resistance magnet, including the high-resistance magnet.

569,266. ELECTRIC BOND; M. J. Wightman, Scranton, Pa. App. filed Feb. 20, 1896. The combination with melting sections of flanged metal traversed by the electric current, of an electric bond consisting of a metal plate lying against said sections with a thin edge contiguous to the edge of the flanges of the respective sections and constructed to allow for expansion and contraction at the joint, the thin edge of the flange and plate being fused together.

569,278. ELECTRIC HEATER; G. B. Fraley, Philadelphia, Pa. App. filed July 11, 1896. An electric heater consisting of a perforated metallic casing open at both ends, a fire-proof inner cylinder, a wall at or near the centre of said cylinder forming two chambers therein, openings in said chamber registering with the perforations in the casing and strands of wire coiled around said fire-proof cylinder through which the current flows.

569,296. TIMING MECHANISM FOR RACES; C. A. Newbaker, Pittsburg, Pa. App. filed Feb. 25, 1896. The combination of an indicating mechanism, a motor, a clutch mechanism for connecting the motor and indicating mechanism, a magnet for shifting the clutch members to closed position, a catch for holding the clutch members in closed position, and a magnet for shifting the catch, the circuits for said magnets being adapted to be closed one at the beginning and the other at the end of the race on the passage of the horse past a predetermined point.

569,299. ELECTRIC SNAP SWITCH; C. G. Perkins, Hartford, Conn. App. filed July 31, 1896. In an electric switch, in combination, a holding-plate adapted to be firmly secured to a supporting part, a base bearing the operating mechanism, yielding connections between the holding-plate and the base, a cover plate outside of the holding-plate and a handle for moving the operating mechanisms, said handle having a part bearing against the cover-plate.

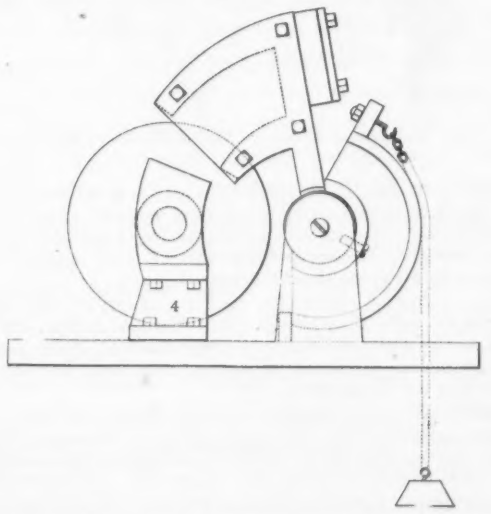
569,300. ELECTRIC SWITCH; W. H. Powell, Hartford, Conn. App. filed Feb. 8, 1896. A single-pole switch having a base with a plural number of pairs of contacts which are unequally spaced about the axis of the base, a handle spindle held by the base and adapted to be given an intermittent rotation and a plural number of insulating conducting posts connected with and moving by the spindle, and adapted to connect the pairs of contacts, said posts being equal in number to the pairs of contacts, and also unequally spaced about the axis of the spindle so that different combinations of pairs of contacts are joined by the successive movements of the posts during the rotation of the handle spindle.

569,301. ELECTRIC SWITCH; W. H. Powell, Hartford, Conn. App. filed Feb. 8, 1896. In a single-pole switch, in combination a base bearing, a plural number of contacts and brushes, one of said contacts being permanently electrically connected with one of said brushes, a handle-spindle supported by the base and adapted to be given an intermittent rotation and insulated connecting posts connected with and intermittently moved by the spindle said connecting posts being arranged at different intervals about the axis of the spindle, so as to join first one set, then more than one set of contacts and brushes as they revolve around the spindle.

569,302. ELECTRIC SWITCH; W. H. Powell, Hartford, Conn. App. filed June 29, 1896. In an electric switch, in combination, a base with a plural number of sets of stationary contacts, one of each of the sets of contacts being electrically connected with one of the sets next in advance, a handle-spindle supported by the base and adapted to be given an intermittent rotation, and plural number of insulated conducting contacts connected with and moving by the turning of the spindle and adapted to connect certain different sets of stationary contacts at each movement of the spindle.

569,305. SYSTEM OF CONTROL FOR ELECTRIC MOTORS; E. A. Sperry, Cleveland, O. App. filed Feb. 21, 1895. In an electric controller, a source of electrical supply, a series electric machine and independent field coil of high resistance for such machine, the controller adapted to assume a position wherein the main circuits are open, in combination with contacts so located in the controller that at the above position of the controller the source of supply is connected with the field coil of high resistance.

569,309. ELECTRIC SNAP SWITCH; G. B. Thomas, Hartford, Conn. App. filed May 16, 1896. A switch having base-bearing contacts, a rotary spindle, a disc of insulating material connected to and movable with the spindle and having recesses in its upper and lower faces, and conducting pieces of spring metal each formed in the shape of a hollow square with one side partially cut away, a part of each square extending onto the upper face, a part extending onto the lower face and the parts of the cut-away sides that project toward each other extending into and loosely resting in the recesses in the upper and lower faces of the disc.



NO. 569,262.—ELECTROMAGNET.

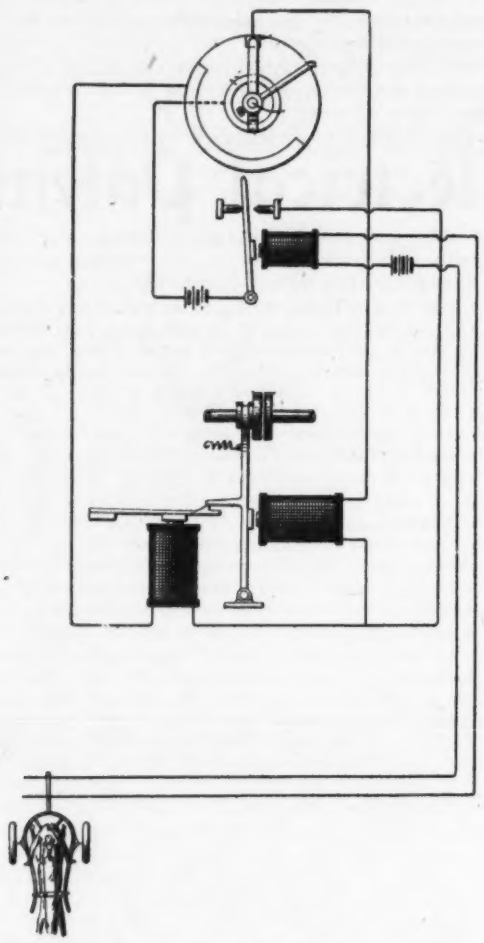
569,331. ELECTRIC RAILWAY; A. Gorton, Philadelphia, Pa. App. filed Dec. 31, 1890. In an electric railway, a chair with a longitudinal recess, a metal sleeve in said recess, a section of an electric wire in said sleeve and insulated therefrom, transmitters connected with said wire, magnets operating said transmitters, and a cover for said recess forming a guide for the current gatherer.

569,332. SNAP SWITCH; G. W. Hart, Hartford, Conn. App. filed July 9, 1896. In a snap switch, in combination, a base, contacts secured to the base, a notched plate on the base, a spindle rotarily supported by the base, a latch movable longitudinally and rotarily independent of the spindle which supports it, said latch having a part adapted to engage the notches in the plate, a conducting-pole carried by the latch, a part connected with the spindle and adapted to engage and move the latch, and a single latch-throwing and locking spring that is engaged by a part connected with the spindle and made tense when the spindle is rotated and that engages a part connected with the latch and tends to hold the latch against longitudinal movement when the spring is being made tense, whichever direction the spindle is rotated.

569,338. TROLLEY-WIRE HANGER; W. S. Kisinger, Bantam, O. App. filed Feb. 8, 1896. The combination in a trolley-wire hanger, of a yoke, an insulated member applied thereto, and having a vertical chamber with a

pair of inclined bearings at its lower end, and a line-wire holder provided with a pair of inclined lugs that engage over said bearings.

569,352. TROLLEY CATCHER; C. F. Randall, Denver, Col. App. filed Feb. 11, 1895. The combination with a tube or casing of a two-part weight located therein, a spring-held rod connecting the two parts of the weight, a dog hinged to the rod, a ratchet located within the tube in suitable proximity to the weight, and a rope or similar connection between the weight and the trolley-pole.



No. 569,296.—Timing Mechanism for Races.

569,373. CUT-OUT FOR ELECTRIC CIRCUITS; L. W. Downes, Providence, R. I. App. filed July 23, 1896. In a safety cut-out, a fuse wire combined with an enclosing sheath, and surrounded by a mass of finely divided refractory material in loose condition, placed in such sheath in such manner as to leave an air-space about the fuse-wire.

569,376. ADJUSTABLE BRACKET FOR TRANSMITTERS; A. Y. Gordon, Massillon, O. App filed July 21, 1896. The combination of a plate having hinged thereto a bar provided with discs, heads pivotally connected to the bar, parallel bars connected to heads at their inner and outer ends, and a bar carrying the transmitter.

569,380. DENTAL CATAPHORIC APPARATUS; M. W. Hollingsworth, Philadelphia, Pa. App. filed June 29, 1896. In cataphoric apparatus, a yielding carrier adapted to be self-conforming to the surface with which contact is to be made.

569,385. MAGNETO-ELECTRIC GENERATOR; C. H. North, Cleveland, O. App. filed April 14, 1896. In a magneto-electric generator, the combination with a rotary armature and vibratory shaft of three springs mounted on an end plate, one of said springs connecting with a pin in the armature shaft, another of said springs connected in the main circuit, and a third spring interposed between the other springs and connected with the main circuit, also connected with the end of the vibratory shaft and adapted thereby for changing the electric current between these springs.

569,401. MULTIPLE STATION TELEPHONE CIRCUIT; J. A. Barrett, Rutland, Vt. App. filed Jan. 27, 1896. A multiple station metallic telephone circuit, and a telephone at each station in a normally open bridge or branch thereof, controlled by an automatic telephone switch, in combination with an independent signaling circuit having a line conductor formed of the two wires of the said metallic circuit joined in parallel, a selective relay at each station in the said signaling circuit, and an associated call signal instrument controlled thereby, each station-relay being adjusted to actuate its call instrument on the passage through its coils of a definite and different strength of calling-current, and to maintain the irresponsiveness of the said call instrument on the passage of stronger or weaker call currents.

569,424. ELECTRIC TROLLEY RAILWAY SIGNAL; H. A. Parrish, Jackson, Mich. App. filed Oct. 23, 1895. Normally open elastic circuit-terminals in combination with a pivoted vertical lever provided with a lateral insulated projection at the upper end, and a spring attached to the side opposite the projection at the upper end and a spring attached to the side opposite the projection and above the point of pivoting to prevent rebounding of lever.

569,432. ELECTRIC RAILWAY SYSTEM; B. R. Shover, Indianapolis, Ind., and F. P. Townsend, Asbury Park, N. J. App. filed Sept. 10, 1895. An electric railway system, comprising a closed conduit, a main circuit-wire located therein, contact-plates fixed within the upper portion of the conduit and having connection with the main wire, other contact-plates in the conduit between the first-named contact-plates, a sectional working-rail between the first-named contact-plates, a sectional working-rail between the track-rails, one of the track-rails being in the return circuit, connections between said other contact-plates and the working-rail, contact strips in the conduit and a permanent magnet carried by a car and connected in series with the motor on the car for moving the strips to contact with the plates.

569,443. SYSTEM OF ELECTRICAL DISTRIBUTION; G. T. Woods, New York, N. Y. App. filed Feb. 5, 1896. The method of operating and regulating the work of an electric motor, consisting in maintaining one coil of the field magnet of the electric motor at a constant strength, supplying its armature from a source of constant potential, supplementing the E. M.F. of said source by E. M. F. from a supplementary source, varying the E M. F. of said supplementary source and at the same time varying the strength of the field-magnet of the motor.

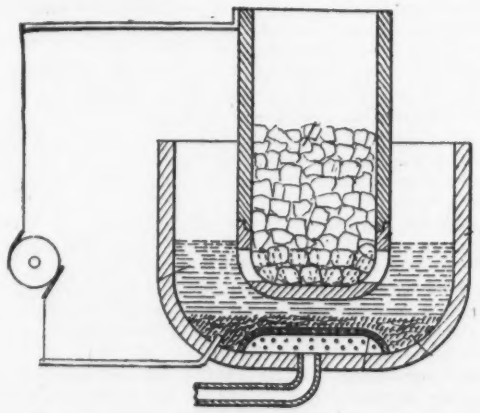
569,470. TELEPHONE EXCHANGE SYSTEM; P. E. Raverot and G. A. Hess, Paris, France. App. filed July 8, 1896. A system for connections for telephone exchange switchboards based on the principle of arithmetical combinations, the subscribers of the exchange being divided up in groups, each of which is represented in the exchange by jackboards with one jack for every subscriber of the group and those jackboards being combined in pairs, forming section switchboards.

569,529. ELECTRO-THERAPEUTIC BAND; B. H. Vellines, Norfolk, Va, App. filed Nov. 30, 1895. In a therapeutic band for personal wear, the combination with a circular perforated band of metal, such as copper, having its end portions reduced in thickness to form extended overlapping adjusting tongues, of a second strip of opposite character, such as zinc, placed around the said copper band, and of the same length as the unreduced portion thereof, and a tape band placed entirely around the zinc and the tongues of the copper, and provided at its end portions with means for their adjustable connection, the upper and lower edge portions of the copper being bent outwardly and over upon the zinc and tape.

569,538. AUTOMATIC CUT-OUT FOR ELECTRICAL TRANSFORMERS; A. C. Booth, Cedar Rapids, Ia. App. filed Feb. 6, 1895. In an automatic cut-out for electric transformers, the combination with primary and secondary circuit wires, of a switch of insulating material and provided with metal contact plates to close the primary and secondary circuits, electromagnets to actuate said switch in two directions, an independent battery, to energize said magnets a magnet in the circuit between said battery and the secondary circuit to close the battery circuit with one of the switch-actuating magnets and a magnet in series with the secondary circuit for interrupting the circuit of the battery with the other switch-actuating magnet.

569,551. BLOCK SIGNAL SYSTEM; J. E. Donbavand, Millville, N. J. App. filed Nov. 23, 1894. The combination with the signal post of a semaphore arm having a knife edge bearing thereon, a toothed segment connected with the arm to swing it to "danger," and operating mechanism geared to the segment.

569,576. ELECTRIC SWITCH; G. Emmet, Attleborough, Mass. App. filed Feb. 26, 1896. In an electric switch, the combination of fixed switch-pieces connecting the terminals of an electric circuit line, and fixed switch-pieces connected to the translating device, with an oscillating switch-carrier having segment switch-pieces electrically insulated from each other, adapted to put the translating device into the electric circuit, or to cut it out and close the line circuit, a spring snap-piece, a spring, a handle for moving both the said oscillating switch-carrier and the spring snap-piece into such a position that the spring will impart rapid movement to the oscillating switch-carrier and the said spring snap-piece and spring.



No. 569,591.—Method of and Means for Electric Generation.

569,591. METHOD OF AND MEANS FOR ELECTRIC GENERATION; S. H. Short, Cleveland, O. App. filed April 9, 1896. The method of converting the potential energy of carbon into electrical energy, which consists in subjecting the carbon to the electrochemical action of oxygen through the negative plate of the cell.